THE

BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

OF

ARTS AND SCIENCES;

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

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BY

MESSRS. LOWRY AND SCOTT.

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LIST OF PLATES

IN

VOL. V.

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THE

BRITISH ENCYCLOPEDIA.

NICERON (John Francis), in biography, a French monk and ingenious mathematician in the seventeenth century, was born at Paris, in the year 1613. He early displayed a love of learning, and by the progress which he made in his elementary studies, afforded fair promise of future excellence. At the age of nineteen he entered into the order of Minims, and before he had gone through his course of philosophy, discovered that his predominant inclination was to the study of mathematical sciences, to which, after he had completed his theological course, he devoted all the time that was not necessarily occupied by the duties of his profession. The science of optics was what principally engaged his attention; and he left behind him, in different houses belonging to his order, particularly that at Paris, some excellent performances, which afforded satisfactory evidence of his profound skill in this branch of the mathematics. He was twice sent on business to Rome, and was appointed regent of the philosophical classes. Afterwards he was nominated to accompany father Francis de la Noue, vicar-general of the order, in his visitation of all the convents of Minims in France. The similarity of their taste proved the means of introducing him to the acquaintance of Des Cartes, who entertained a great regard for him, and made him a present of his "Principles of Philosophy." Their intimacy, however, which commenced in 1644, proved but of short duration, since our young monk fell sick at Aix in Provence, and died there in the autumn of 1646, when he was only thirty-three years of age. This event was lamented as a considerable loss to the republic of letters. He was the author of the following works, which are held in high estimation. "The Interpretation of Cyphers, or, a Rule for the perfect Understanding and certain Explanation of all Kinds of simple Cyphers, taken from the Italian of the Sieur Anthony Maria Cospi, secretary to the Grand Duke of Tuscany; enlarged, and particularly accommodated to the French and Spanish Languages," 1641, octavo; "Curious Perspective, or artificial Magic, produced by the wonderful Effects of Optics, Catoptrics, and Dioptrics," &c. 1638, folio; which was only introductory to his "Thaumaturgus Opticus, sive, admirandæ Optices, Catoptrices, et Dioptrices, Pars prima, de iis quæ spectant ad visionem directam," 1646, folio. On this work he was employed six years, and was prevented by his death from proceeding to the completion of the intended second and third parts, relating to the effects of reflection from plane, cylindrical, and conical mirrors, and the refraction of crystals. This task his friend father Mersenne undertook, not only by correcting what Niceron's papers in Latin and French would furnish towards it, but by supplying what might be necessary to perfect it. But the other occupations of this learned mathematician, during the two remaining years of his own life, prevented him from finishing the work, which, upon his death, was committed for that purpose to M. de Roberval, professor royal of mathematics at Paris. A "Letter" of Father Niceron's is inserted in the third volume of Liceto's "De quæsitis per Epistolas."

NICHE, in architecture, a hollow sunk

into a wall, for the commodious and agreeable placing a statue.

NICKEL. A white metal, which, when obtained pure, is both ductile and malleable. It may be forged into very thin plates, their thickness not being greater than 0.01 of an inch. Its colour is intermediate between that of silver and tin, and is not altered by the air. It is nearly as hard as iron. Its specific gravity is 8.279, and when forged 8.666.

The species of nickel ores are its alloy with arsenic, and a little sulphur and its oxide.

The first is the most abundant, and the one from which nickel is usually extracted. It is known to mineralogists by the name of kupfer-nickel, or copper-nickel, from its colour and appearance. It occurs generally massive and disseminated; its colour is copper-red of various shades; its lustre is weakly, shining, and metallic; it is perfectly opaque; its fracture is uneven; it is hard, has no malleability, but is not easily broken; its specific gravity is from 6.6 to 7.5. Urged by the flame of the blow-pipe, it gives vapours with a strong arsenical odour, and melts with difficulty. It dissolves in acids, giving a green solution. Bergman found it to be composed of nickel, iron, cobalt, arsenic, and sulphur. Vauquelin regards it as essentially an alloy of nickel and arsenic, the iron, cobalt, and sulphur, being accidental.

The other species, the oxide of nickel, occurs generally as an incrustation, sometimes also disseminated of a friable texture and earthly appearance; of an apple green colour, without lustre. It is not altered by the heat of the blow-pipe; but when mixed with borax, gives to it a yellowish red colour. Its solution in acids is of a green colour. It occurs generally with kupfer-nickel, or with certain cobalt ores. It is also contained in small quantities in a fossil of the siliceous genus, chrysoprase, to which it communicates an apple-green colour.

Nickel is extracted from the kupfer-nickel, but it is extremely difficult to free it entirely from the metals with which it is associated. The process given by Chenevix is the most simple. The metal obtained from kupfer-nickel, by roasting and fusion with three times its own weight of black flux, is dissolved in nitric acid, the solution being boiled, so that the arsenic present receiving oxygen from the acid may be converted into arsenic acid; a solution of nitrate of lead is then dropped in, and the liquor evaporated by a very gentle heat but not quite to dryness. Alcohol poured into this solution precipitates every salt, but the nitrate of nickel, which has been formed by the double decomposition of the arseniate of nickel and the nitrate of lead. The alcohol of the solution of nitrate of nickel being evaporated, the metallic salt is redissolved in water and decomposed by potash. The oxide, well washed and dried, is reduced in an Hessian crucible lined with lamp-black.

By the experiments that have been made on nickel in its pure state, it appears to be proved that it is possessed of magnetic power, and that therefore iron is not the only metal to which it belongs. The magnetic properties of nickel had often been observed; but as in the usual processes by which it is obtained, it is always alloyed with iron; it was concluded, with probability, that the magnetism it exhibited was owing to the presence of that metal. Since methods, however, have since been discovered of obtaining nickel in a purer state, the error of this conclusion has been discovered. The effect of the magnet on it is very little inferior to that which it exerts on iron; and the metal itself becomes magnetic itself by friction with a magnet, or even by beating with a hammer. Magnetic needles have even been constructed of it in France, and have been preferred to those of steel, as resisting better the action of the air. The nickel preserves its magnetic property when alloyed with copper, though it is somewhat diminished; by a small portion of arsenic it is completely destroyed.

Nickel is extremely fusible; its fusing point being higher than that of iron.

This metal is oxyded by exposure to the atmospheric air at a high temperature, though with difficulty. Its oxide is more easily obtained by exposure to heat with nitre; it is of an apple green colour, and is obtained likewise of this colour by precipitation from some of its saline combinations. It appears to be the oxide at the minimum of oxydement; at least, according to the experiments of Thenard, another oxide can be formed more highly oxyded. It may be obtained by exposing the green oxide to a red heat, or by heating it with oxymuriatic acid. It appears therefore to be too highly oxydized to be capable of directly combining with any of the acids. According to Richter, oxide of nickel is reduced by heat

alone; and the only difficulty experienced is the intensity of the heat required to fuse the metal.

Nickel is oxydized and dissolved by a number of acids; its solutions being generally of a green colour and crystallizable.

The salts of nickel are decomposed by the alkalies, and the oxide, more or less free from the acid, is thrown down. If the alkalies are added in excess, they re-dissolve it; and with ammonia in particular, soluble triple salts are formed. Potash and soda dissolve even a small quantity of its pure oxide; ammonia dissolves it in a much larger quantity.

Nickel combines with sulphur by fusion. The compound has a yellow colour with some brilliancy. It is brittle and hard, and burns when strongly heated in contact with the air. Nickel is also dissolved by the alkaline sulphurets.

With phosphorus, nickel unites, either by projecting the phosphorus on the nickel at a high temperature, or by heating together phosphoric acid and nickel with a little charcoal. The nickel increases in weight one-fifth. The compound is of a white colour with metallic lustre, and appears composed of a congeries of prisms.

Nickel forms alloys with a number of the metals; but our knowledge of these combinations is very imperfect.

NICOTIANA, in botany, *tobacco*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel form, with a plaited border; stamina inclined; capsule two-valved, two-celled. There are seven species, of which N. rustica, English tobacco, seldom rises more than three feet in height, having smooth alternate leaves upon short foot stalks; flowers in small loose bunches on the top of the stalks, of a yellow colour, appearing in July, which are succeeded by roundish capsules, ripening in the autumn. Sir Walter Raleigh, on his return from America, is said to have first introduced the smoking of tobacco into England. In the house in which he lived at Islington, are his arms, with a tobacco plant on the top of the shield. It is remarkable that tobacco has prevailed over the original name, petum, in all the European languages with very little variation, and even in Tartary and Japan. Tobacco is derived from the island Tobago. Petum is the Brasilian name.

NICTITATING *membrane*, in comparative anatomy, a thin membrane, chiefly found in the bird and fish-kind, which covers the eyes of these animals, sheltering them from the dust or from too much light; yet is so thin and pellucid, that they can see pretty well through it.

NIDUS, among naturalists, signifies a nest, or proper repository for the eggs of birds, insects, &c. wherein the young of these animals are hatched and nursed.

NIEUWENTYT (Bernard), in biography, a celebrated Dutch philosopher and mathematician, in the seventeenth and early part of the eighteenth century, was the son of a minister of Westgraafdyk, in North Holland, where he was born in the year 1654. He afforded early indications of a good genius, and a love of learning, which his father took care to encourage, by giving him the advantages of an excellent education. He was desirous of becoming acquainted with all the branches of knowledge; but he had the prudence and sagacity to proceed gradually in his acquirements, and to make himself master of one science, before he directed his attention to another. It was his father's wish that he should be educated to his own profession; but when he found that his son was disinclined to such a destination, he very properly suffered him to follow the bent of his own genius. The first science to which young Nieuwentyt particularly directed his study, was logic, in order to fix his imagination, to form his judgment, and to acquire a habit of right reasoning; and in this science he grounded himself upon the principles of Des Cartes, with whose philosophy he was greatly delighted. In the next place, he engaged in the study of the mathematics, with the various departments of which he became intimately conversant.

He then entered upon the study of medicine, and the branches of knowledge more immediately connected with that science; and he afterward went through a course of reading on jurisprudence. In the study of all these sciences he succeeded so well, as deservedly to acquire the character of a good philosopher, a good mathematician, and an able just magistrate. From his writings it also appears, that he did not permit his various subjects of inquiry to divert his thoughts from a due attention to the great and fundamental principles of natural and revealed religion. He was naturally of a grave and serious disposition; but at the same time a very affable and agreeable companion. So engaging were his manners, that they conciliated the

esteem of all his acquaintance; by which means he frequently drew over to his opinion those who differed widely from him in sentiment. With such a character, he acquired great credit and influence in the council of the town of Puremerende, where he resided; and also in the states of that province, who respected him the more, because he never engaged in any cabals or factions, but recommended himself only by an open, manly, and upright behaviour. Had he aspired after some of the higher offices of government, there is no doubt but that his merits would have secured to him the suffrages of his countrymen; yet he preferred to such honours the cultivation of the sciences, contenting himself with being counsellor and burgomaster, without courting or accepting any other posts, which might interfere with his studies. He died in 1718, at the age of sixty-three, having been twice married. He was the author of various works, among which are, "Considerationes circa Analyseos ad quantitates Infinite parvas applicatæ Principia, &c." 1694, octavo; in which he proposed some difficulties on the subject of the analysis of infinitesimals. "Anylysis Infinitorum, seu Curvilineorum proprietates, ex Polygonorum deductæ," 1696, quarto; which is a sequel to the former, with attempts to remove those difficulties. "Considerationes Secundæ circa Calculi Differentialis Principia, et Responsio ad Virum nobilissum G. G. Leibnitium, &c." 1696, quarto; occasioned by an attack of Leibnitz on the author's "Analysis," in the Leipsic Journal for 1695. "A Treatise on the new Use of the Tables of Sines and Tangents," 1714. "The proper Use of the Contemplation of the Universe, for the Conviction of Atheists and Unbelievers," 1715, quarto; of which a French translation was published at Paris, in 1725, quarto, entitled, "L'Existence de Dieu demontrée par les Merveilles de la Nature;" and also an English one at London, in 1716, in three volumes, octavo, under the title of "The Religious Philosopher, or, the right Use of contemplating the Works of the Creator." A Memoir inserted in a Dutch Journal, entitled, "Bibliothéque de l'Europe," for the year 1716, in defence of the preceding work against a criticism of M. Bernard, in the "Nouvelles de la Republique des Lettres." "A Letter to M. Bothnia de Burmania, on his Article concerning Meteors," inserted in the "Nouvelles litter. du 22 Avril, 1719:" and about a month before his death, he put the finishing hand to an excellent refutation of Spinoza, which was published in Dutch at Amsterdam, in 1720, quarto.

NIGELLA, in botany, *fennel flower*, a genus of the Polyandria Pentagynia class and order. Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary five, two-lipped, within the corolla; capsule as many, connected. There are five species; these are annual herbaceous plants, with pinnate or bipinnate leaves, and linear leaflets; flowers terminating, in some species, surrounded with a five-leaved calyx like multifid involucre.

NIGHT, that part of the natural day during which the sun is underneath the horizon; or that space wherein it is dusky. Night was originally divided by the Hebrews, and other eastern nations, into three parts, or watchings. The Romans, and afterwards the Jews from them, divided the night into four parts, or watches, the first of which began at sun-set and lasted till nine at night, according to our way of reckoning; the second lasted till midnight; the third till three in the morning; and the fourth ended at sun-rise. The ancient Gauls and Germans divided their time not by days but by nights; and the people of Iceland and the Arabs do the same at this day. The like is also observed of our Saxon ancestors.

NIGHTINGALE. See MOTACILLA.

NIGRINE, in mineralogy, a species of the Menachine genus. Colour dark brownish-black, passing to velvet black; it occurs in larger and smaller angular grains; specific gravity 4.5. It is not attracted by the magnet; it is infusible *per se*, but with borax it melts to a transparent hyacinth-red globule; it yields its menachine to acid of sugar. This species is found in Transylvania, consisting of yellow sand, intermixed with fragments of granite, gneiss, and mica-slate, and from which gold is obtained by washing. It comes to us commonly intermixed with grains of precious garnet, cyanite, and common sand. Its name is derived from its black colour; it is distinguished from menachanite by its stronger lustre, superior hardness, the colour of the streak, as well as by its not being in the smallest degree affected by the magnet, which also distinguishes it from iron-sand. Its constituent parts are,

Oxide of menachine	84
Oxide of iron	14
Oxide of manganese	2
	100

NILOMETER, sometimes called *Niloscope*, an instrument used among the ancients to measure the height of the water in the river Nile, in its periodical overflowings. It was first set up, it has been asserted, by Joseph, during his government in Egypt. The measure of it was sixteen cubits, this being the height to which it must rise in order to insure the fruitfulness of the country.

NINTH, in music, an interval containing an octave and a tone; also a name given to the chord consisting of a common chord with the eighth advanced one note.

NIPA, in botany, a genus of the Appendix Palmæ class. Natural order of Palmæ or Palms. Essential character: male, spathe; corolla six-petalled: female, spathe; corolla none; drupes angular. There is but one species, *viz.* N. fruticans, the young palm, is without the trunk; but in the adult state, it is some feet in height; leaves pinnate; pinnas striated, margined, and smooth; flowers male and female on the same palm; but distinct on different peduncles: males several, lateral, inferior, on dichotomous peduncles, in spikes: females terminating, aggregate in a globular head, sessile. It is a native of Java and other islands in the East Indies, where the leaves are used for covering houses and making mats. The fruit is eaten both raw and preserved.

NIPPLES, in anatomy. See MAMMARY *gland*.

NISI PRIUS, a commission directed to the judges of assize, empowering them to try all questions of fact issuing out of the courts at Westminster, that are then ready for trial by jury. The original of which name is this: all causes commenced in the courts of Westminster-hall, are, by course of the courts, appointed to be tried on a day fixed in some Easter or Michaelmas term, by a jury returned from the county where the cause of action arises; but with this proviso, *nisi prius justiciarii ad assisas capiendas venerint*: that is, unless before the day prefixed, the judges of assize came into the county in question, which they always do in the vacation preceding each Easter and Michaelmas term, and there try the cause: and then, upon the return of the verdict given by the jury, to the court above, the judges there give judgment for the party for whom the verdict is found. All trials at law, in the civil courts and at the assizes, are tried by this process, and are called trials at nisi prius.

NISSOLIA, in botany, so named in honour of Guill. Nissole, M. D., of Montpellier; a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx five-toothed; capsule one-seeded, ending in a ligulate wing. There are two species, *viz.* N. arborea, tree nissolia; and N. fruticosa, shrubby nissolia, both natives of Carthagena, in woods and coppices.

NITIDULA, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club solid; shell margined; head prominent; thorax a little flattened, margined. There are about forty-two species enumerated by Gmelin, separated into sections according to the form of the lip. A. Lip cylindrical. B. Lip square. N. bipustulata, is oval, black; shells with a red dot. It inhabits Europe, and lives on carcases, meat, bacon, &c.

NITRARIA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Ficoideæ, Jussieu. Essential character: calyx five-cleft; corolla five-petalled, with the petals arched at top; stamina fifteen or more; drupe one-seeded. There is but one species, *viz.* N. schoberi. Thick-leaved Nitraria.

NITRATES, in chemistry, salts formed of the nitric acid, and alkalies, earths, &c. They possess the following properties: soluble in water, and capable of crystallizing by cooling; when heated to redness with combustible bodies, a violent combustion and detonation is produced: sulphuric acid disengages from them fumes which have the odour of nitric acid: when heated with muriatic acid, oxymuriatic acid is driven off: they are decomposed by heat, and yield at first oxygen gas. There are twelve nitrates, of which the most important is the nitrate of potash, or nitre: this salt, known also by the name of salt-petre, is produced naturally in considerable quantities, particularly in Egpyt, and has been known from time immemorial. Roger Bacon mentions it under the name of nitre, in the thirteenth century. The importance of this substance for the purposes of war, has led chemists to seek the best means of preparing it, especially as nature has not laid up large magazines of it, as she has of other salts. It is now ascertained, that nothing more is necessary for the production of nitre than a basis of lime, heat, and an open, but not too free communication with dry atmospheric air. When these circumstances combine, the acid is first formed, and afterwards the alkali. See NITRIC *acid*.

NITRE. See NITRATES. Nitre is found abundantly on the surface of the earth, in India, South America, South Africa, and even in some parts of Spain. In Germany and France it is obtained by means of artificial nitre-beds. These consist of the refuse of animal and vegetable bodies, undergoing putrefaction, mixed with calcareous and other earths. It has been ascertained, that if oxygen gas be presented to azote at the instant of its disengagement, nitric acid is formed. This seems to explain the origin of the acid in these beds. The azote, disengaged from these putrifying animal substances, combines with the oxygen of the air. The potash is probably furnished, partly at least, by the vegetables and the soil. The nitre is extracted from these beds, by lixiviating the earthy matters with water. This water, when sufficiently impregnated, is evaporated, and a brown-coloured salt obtained, known by the name of crude nitre. It consists of nitre, common salt, nitrate of lime, and various other salts. The foreign salts are either separated by repeated crystallizations, or by washing the salt repeatedly with small quantities of water; for the foreign salts being more soluble, are taken up first. Nitre, when slowly evaporated, is obtained in six-sided prisms, terminated by six-sided pyramids; but for most purposes, it is preferred in an irregular mass, because in that state it contains less water. The specific gravity of nitre, as ascertained by Dr. Watson, is 1.9. Its taste is sharp, bitterish, and cooling. It is very brittle. It is soluble in seven times its weight of water, at the temperature of 60°, and in rather less than its own weight of boiling water. When exposed to a strong heat it melts, and congeals by cooling into an opaque mass, which has been called mineral crystal. Whenever it melts, it begins to disengage oxygen; and, by keeping it in a red heat, about the third of its weight of that gas may be obtained: towards the end of the process azotic gas is disengaged. If the heat be continued long enough, the salt is completely decomposed, and pure potash remains behind. It detonates more violently with combustible bodies than any of the other nitrates. When mixed with one-third part of its weight of charcoal, and thrown into a red-hot crucible, or when charcoal is thrown into red-hot nitre, detonation takes place, and one of the most brilliant combustions that can be exhibited. The residuum is carbonate of potash. A still more violent detonation takes place, if phosphorus is used instead of charcoal. Nitre oxydizes all the metals at a red heat. The composition of nitre, according to Kirwan, is

Acid	44
Potash	51.8
Water	4.2
	100.0

Nitre furnishes all the nitric acid in all its states, employed either by chemists or artists: it is obtained by decomposing it by means of the sulphuric acid. When burnt with tartar, it yields a pure carbonate of potash. In the assaying of various ores it is indispensable, and is equally necessary in the analysis of many vegetable and animal substances. But one of the most important compounds, formed by means of nitre, is gunpowder, which has completely changed the modern art of war. The discoverer of this compound, and the person who first thought of applying it to the purposes of war, are unknown. It is certain, however, that it was used in the fourteenth century. From certain archives, quoted by Wiegleb, it appears, that cannons were employed in Germany before the year 1372. No traces of it can be found in any European author, previous to the thirteenth century; but it seems to have been known to the Chinese long before that period. There is reason to believe, that cannons were used in the battle of Cressy, which was fought in 1346. They seem even to have been used three years earlier at the siege of Algesiras; but before this time, they must have been known in Germany, as there is a piece of ordnance at Amberg, on which is inscribed the year 1303. Roger Bacon, who died in 1292, knew the properties of gunpowder; but it does not follow that he was acquainted with its application to fire-arms. See GUNPOWDER. When three parts of nitre, two parts of potash, and one part of sulphur, all previously well dried, are mixed together in a warm mortar, the resulting compound is known by the name of fulminating powder. If a little of this powder be put into an iron spoon, and placed upon burning coals, or held above the flame of a candle, it gradually blackens, and at last melts. At that instant it explodes with a very violent report, and a strong impression is made upon the bottom of the spoon, as if it had been pressed down very violently. This sudden and violent combustion is occasioned by

the rapid action of the sulphur on the nitre. By the application of the heat, the sulphur and potash form a sulphuret, which is combustible at a lower heat probably than even sulphur. Sulphurated hydrogen gas, azotic gas, and perhaps also sulphurous acid gas, are disengaged almost instantaneously. It is to the sudden action of these on the surrounding air that the report is to be ascribed. Its loudness evidently depends upon the combustion of the whole powder at the same instant, which is secured by the previous fusion that it undergoes; whereas the grains of gunpowder burn in succession. A mixture of equal parts of tartar and nitre, deflagrated in a crucible, is known by the name of white flux. It is merely a mixture of carbonate of potash, with some pure potash. When two parts of tartar, and one of nitre, are deflagrated in this manner, the residuum is called black flux from its colour. It is merely a mixture of charcoal and carbonate of potash.

Nitre is much used in medicine, in fevers, as a cooling remedy, and as a diuretic, in urinary affections. It is employed also in many arts, as in dying; and in domestic economy, for the preservation of animal substances used for food. To these substances it imparts a red colour. See NITROUS *acid*; also GUNPOWDER.

NITRIC *acid*. The two principal constituent parts of our atmosphere, when in certain proportions, are capable, under particular circumstances, of combining chemically, into one of the most powerful acids, the nitric, which consists, according to Mr. Davy, of 70.5 of oxygen, and 29.5 of azote, or nitrogen. If these gases be mixed in this proportion in a glass tube, about a line in diameter, over mercury, and a series of electric shocks be passed through them for some hours, they will form nitric acid; or, if a solution of potash be present with them, nitrate of potash will be obtained. The constitution of this acid may be further proved, analytically, by driving it through a red-hot porcelain tube, as thus it will be decomposed into oxygen and nitrogen gases. For all practical purposes, however, the nitric acid is obtained from nitrate of potash, from which it is expelled by sulphuric acid.

Four parts of pure nitrate of potash, coarsely powdered, are to be put into a glass retort, and three parts of concentrated sulphuric acid cautiously added, taking care to avoid the fumes that arise, which is best done by standing in a current of air to convey them up the chimney. Join to the retort a tubulated receiver of large capacity, with an adopter interposed, and lute the junctures with a mixture of pipeclay, sifted sand, and cut tow. In the tubulure fix with fat lute a glass tube terminating in another large receiver, in which is a small quantity of water; and, if you wish to collect the gaseous products, let a bent glass tube from this receiver communicate with a pneumatic trough. Apply heat to the receiver by means of a sand bath. The first product that passes into the receiver is generally red and fuming; but the appearances gradually diminish, till the acid comes over pale, and even colourless, if the materials used were clean. After this it again becomes more and more red and fuming, till the end of the operation; and the whole mingled together will be of a yellow or orange colour.

In the large way, and for the purposes of the arts, extremely thick cast iron or earthen retorts are usually employed, to which an earthen head is adapted, and connected with a range of proper condensers. The strength of the acid too is varied, by putting more or less water in the receivers. The nitric acid thus made generally contains sulphuric acid, and also muriatic from the impurity of the nitrate employed. If the former, a solution of nitrate of barytes will occasion a white precipitate: if the latter, nitrate of silver will render it milky. The sulphuric acid may be separated by a second distillation from very pure nitre, equal in weight to an eighth of that originally employed; or by precipitating with nitrate of barytes, decanting the clear liquid, and distilling it. The muriatic acid may be separated by proceeding in the same way with nitrate of silver, or with litharge, decanting the clear liquor, and redistilling it, leaving an eighth or tenth part in the retort. The acid for the last process should be condensed as much as possible, and the redistillation conducted very slowly; and if it be stopped when half is come over, beautiful crystals of muriate of lead will be obtained on cooling the remainder, if litharge be used, as M. Steinacher informs us; who also adds, that the vessels should be made to fit tight by grinding, as any lute is liable to contaminate the product.

As this acid still holds in solution more or less nitrous gas, it is not, in fact, nitric acid, but a kind of nitrous: it is therefore necessary to put it into a retort, to which a re-

ceiver is added, the two vessels not being luted, but merely joined by paper; and to apply a very gentle heat for several hours, changing the receiver as soon as it is filled with red vapours. The nitrous gas will thus be expelled, and the nitric acid will remain in the retort, as limpid and colourless as water. It should be kept in a bottle secluded from the light, otherwise it will lose part of its oxygen.

The strongest acid that Mr. Kirwan could procure at 60° was 1.5543, which by his calculation contained .7354 of real acid; but Rouelle professes to have obtained it of 1.583. It is observable, that, on comparing the tables of Kirwan and Davy, the aëriform acid appears to contain a considerable portion of water more than that which is combined with soda to form the nitrate.

Nitric acid should be of the specific gravity of 1.5, or a little more, and colourless. It boils at 248°, and may be distilled without any essential alteration. Exposed to the air it absorbs moisture. If two parts be suddenly diluted with one of water, the temperature will rise to about 112°; but the addition of more water to this diluted acid will lower its temperature. It retains its oxygen with little force, so that it is decomposed by all combustible bodies. Brought into contact with hydrogen gas at a high temperature, a violent detonation ensues, so that this must not be done without great caution. It inflames volatile oils, such as those of turpentine and cloves, when suddenly poured on them: but, to perform this experiment with safety, the acid must be poured out of a bottle tied to the end of a long stick, otherwise the operator's face and eyes will be greatly endangered. If it be poured on perfectly dry charcoal powder, it excites combustion, with the emission of copious fumes. By boiling it with sulphur it is decomposed, and its oxygen, uniting with the sulphur, forms sulphuric acid. Chemists in general agree, that it acts very powerfully on almost all the metals: but Baumé has asserted, that it will not dissolve tin; and Dr. Woodhouse of Pennsylvania affirms, that in a highly concentrated and pure state it acts not at all on silver, copper, or tin, though with the addition of a little water its action on them is very powerful. He does not mention the specific gravity of this acid: he only says, that it was prepared by first expelling the water of crystallization from nitre by heat, and then decomposing this nitre by means of strong sulphuric acid.

The nitric acid is of considerable use in the arts. It is employed for etching on copper; as a solvent of tin to form with that metal a mordant for some of the finest dyes; in metallurgy and assaying; in various chemical processes, on account of the facility with which it parts with oxygen and dissolves metals; in medicine as a tonic, and as a substitute for mercurial preparations in siphylis and affections of the liver; as also in the form of vapour to destroy contagion. For the purposes of the arts it is commonly used in a diluted state, and contaminated with the sulphuric and muriatic acids, by the name of aqua fortis. This is generally prepared by mixing common nitre with an equal weight of sulphate of iron, and half its weight of the same sulphate calcined, and distilling the mixture: or by mixing nitre with twice its weight of dry powdered clay, and distilling in a reverberatory furnace. Two kinds are found in the shops, one called double aqua fortis, which is about half the strength of nitric acid; the other simply aqua fortis, which is half the strength of the double.

A compound made by mixing two parts of the nitric acid with one of muriatic, known formerly by the name of aqua regia, and now by that of nitro-muriatic acid, has the property of dissolving gold and platina. On mixing the two acids, heat is given out, an effervescence takes place, oxygenated muriatic acid gas is evolved, and the mixture acquires an orange colour. This is likewise made by adding gradually to an ounce of powdered muriate of ammonia, four ounces of double aqua fortis, and keeping the mixture in a sand-heat till the salt is dissolved; taking care to avoid the fumes, as the vessel must be left open: or by distilling nitric acid with an equal weight, or rather more, of common salt.

With the different bases the nitric acid forms nitrates.

The nitrate of barytes, when perfectly pure, is in regular octaëdral crystals, though it is sometimes obtained in small shining scales. It may be prepared by uniting barytes directly with nitric acid, or by decomposing the carbonate of sulphuret of barytes with this acid. Exposed to heat it decrepitates, and at length gives out its acid, which is decomposed; but if the heat be urged too far, the barytes is apt to vitrify with the earth of the crucible. It is soluble in 12 parts of cold, and 3 or 4 of boiling water. It is said to exist in some mineral waters.

The nitrate of potash is the salt well known by the name of nitre, or saltpetre. It is found ready formed in the East Indies, in Spain, in the kingdom of Naples, and elsewhere, in considerable quantities; but nitrate of lime is still more abundant. Far the greater part of the nitrate made use of is produced by a combination of circumstances which tend to compose and condense nitric acid. This acid appears to be produced in all situations, where animal matters are completely decomposed with access of air, and of proper substances with which it can readily combine. Grounds frequently trodden by cattle, and impregnated with their excrements, or the walls of inhabited places where putrid animal vapours abound, such as slaughter-houses, drains, or the like, afford nitre by long exposure to the air. Artificial nitre beds are made by an attention to the circumstances in which this salt is produced by nature. Dry ditches are dug, and covered with sheds, open at the sides, to keep off the rain: these are filled with animal substances, such as dung, or other excrements, with the remains of vegetables, and old mortar, or other loose calcareous earth; this substance being found to be the best and most convenient receptacle for the acid to combine with. Occasional watering, and turning up from time to time, are necessary, to accelerate the process, and increase the surfaces to which the air may apply; but too much moisture is hurtful. When a certain portion of nitrate is formed, the process appears to go on more quickly: but a certain quantity stops it altogether, and after this cessation the materials will go on to furnish more, if what is formed be extracted by lixiviation. After a succession of many months, more or less, according to the management of the operation, in which the action of a regular current of fresh air is of the greatest importance, nitre is found in the mass. If the beds contained much vegetable matter, a considerable portion of the nitrous salt will be common saltpetre; but, if otherwise, the acid will, for the most part, be combined with the calcareous earth.

To extract the saltpetre from the mass of earthy matter, a number of large casks are prepared, with a cock at the bottom of each, and a quantity of straw within, to prevent its being stopped up. Into these the matter is put, together with wood-ashes either strewed at top, or added during the filling. Boiling water is then poured on, and suffered to stand for some time; after which it is drawn off, and other water added in the same manner, as long as any saline matter can be thus extracted. The weak brine is heated, and passed through other tubs, until it becomes of considerable strength. It is then carried to the boiler, and contains nitre and other salts; the chief of which is common culinary salt, and sometimes muriate of magnesia.

It is the property of nitre to be much more soluble in hot than cold water; but common salt is very nearly as soluble in cold as in hot water. Whenever, therefore, the evaporation is carried by boiling to a certain point, much of the common salt will fall to the bottom, for want of water to hold it in solution, though the nitre will remain suspended by virtue of the heat. The common salt thus separated is taken out with a perforated ladle, and a small quantity of the fluid is cooled, from time to time, that its concentration may be known by the nitre which crystallizes in it. When the fluid is sufficiently evaporated, it is taken out and cooled, and great part of the nitre separates in crystals; while the remaining common salt continues dissolved, because equally soluble in cold and in hot water. Subsequent evaporation of the residue will separate more nitre in the same manner.

This nitre, which is called nitre of the first boiling, contains some common salt; from which it may be purified by solution in a small quantity of water, and subsequent evaporation: for the crystals thus obtained are much less contaminated with common salt than before; because the proportion of water is so much larger with respect to the small quantity contained by the nitre, that very little of it will crystallize. For nice purposes, the solution and crystallization of nitre are repeated four times. The crystals of nitre are usually of the form of six-sided flattened prisms, with diedral summits. Its taste is penetrating; but the cold produced, by placing the salt to dissolve in the mouth, is such as to predominate over the real taste at first. Seven parts of water dissolve two of nitre, at the temperature of sixty degrees: but boiling water dissolves its own weight. One hundred parts of alcohol, at a heat of one hundred and seventy-six degrees, dissolve only 2.9.

On being exposed to a gentle heat, nitre fuses; and in this state being poured into moulds, so as to form little round cakes, or balls, it is called sal prunella, or crystal mineral. This at least is the way in which

this salt is now usually prepared, conformably to the directions of Boerhaave; though in most dispensatories a twenty-fourth part of sulphur was directed to be deflagrated on the nitre, before it was poured out. This salt should not be left on the fire after it has entered into fusion, otherwise it will be converted into a nitrite of potash. If the heat be increased to redness, the acid itself is decomposed, and a considerable quantity of tolerably pure oxygen gas is evolved, succeeded by nitrogen.

This salt powerfully promotes the combustion of inflammable substances. Two or three parts mixed with one of charcoal, and set on fire, burn rapidly; azote and carbonic acid gas are given out, and a small portion of the latter is retained by the alkaline residuum, which was formerly called clyssus of nitre. Three parts of nitre, two of subcarbonate of potash, and one of sulphur, mixed together in a warm mortar, form the fulminating powder; a small quantity of which, laid on a fire-shovel, and held over the fire till it begins to melt, explodes with a loud sharp noise. Mixed with sulphur and charcoal it forms gunpowder. See Gunpowder.

Three parts of nitre, one of sulphur, and one of fine saw-dust, well mixed, constitute what is called the powder of fusion. If a bit of base copper be folded up and covered with this powder in a walnut shell, and the powder be set on fire with a lighted paper, it will detonate rapidly, and fuse the metal into a globule of sulphuret, without burning the shell.

If nitrate of potash be heated in a retort, with half its weight of solid phosphoric or boracic acid, as soon as this acid begins to enter into fusion it combines with the potash, and the nitric acid is expelled, accompanied with a small portion of oxygen gas and nitric oxide.

Silex, alumine, and barytes, decompose this salt in a high temperature by uniting with its base, as was observed when speaking of aqua fortis. The alumine will effect this even after it has been made into pottery.

The uses of nitre are various. Beside those already indicated, it enters into the composition of fluxes, and is extensively employed in metallurgy: it serves to promote the combustion of sulphur in fabricating its acid; it is used in the art of dying; it is added to common salt for preserving meat, to which it gives a red hue; it is an ingredient in some frigorific mixtures; and it is prescribed in medicine, as cooling, febrifuge, and diuretic, and some have recommended it mixed with vinegar as a very powerful remedy for the sea scurvy.

Nitrate of soda, formerly called cubic or quadrangular nitre, approaches in its properties the nitrate of potash; but differs from it in being somewhat more soluble in cold water, though less in hot, which takes up little more than its own weight; in being inclined to attract moisture from the atmosphere; and in crystallizing in rhombs, or rhomboidal prisms. It may be prepared by saturating soda with the nitric acid, by precipitating nitric solutions of the metals, or of the earths, except barytes, by soda: by lixiviating and crystallizing the residuum of common salt distilled with three-fourths its weight of nitric acid; or by saturating the mother waters of nitre with soda instead of potash.

This salt has been considered as useless; but professor Proust says, that five parts of it, with one of charcoal and one of sulphur, will burn three times as long as common powder; so as to form an œconomical composition for fire-works.

Nitrate of strontian may be obtained in the same manner as that of barytes, with which it agrees in the shape of its crystals, and most of its properties. It is much more soluble, however, requiring but four or five parts of water according to Vauquelin, and only an equal weight according to Mr. Henry. Boiling water dissolves nearly twice as much as cold. Applied to the wick of a candle, or added to burning alcohol, it gives a deep red colour to the flame. On this account it might be useful, perhaps, in the art of pyrotechny.

Nitrate of lime, the calcareous nitre of older writers, abounds in the mortar of old buildings, particularly those that have been much exposed to animal effluvia, or processes in which azote is set free. Hence it abounds in nitre beds, as was observed when treating of the nitrate of potash. It may also be prepared artificially by pouring dilute nitric acid on carbonate of lime. If the solution be boiled down to a syrupy consistence, and exposed in a cool place, it crystallizes in long prisms, resembling bundles of needles diverging from a centre. These are soluble, according to Henry, in an equal weight of boiling water, and twice their weight of cold; soon deliquesce on exposure to the air; and are decomposed at a red heat. Fourcroy says, that cold water dissolves four times its weight, and

that its own water of crystallization is sufficient to dissolve it at a boiling heat. It is likewise soluble in less than its weight of alcohol. By evaporating the aqueous solution to dryness, continuing the heat till the nitrate fuses, keeping it in this state five or ten minutes, and then pouring it into an iron pot previously heated, we obtain Baldwin's phosphorus. This, which is, perhaps, more properly nitrite of lime, being broken to pieces, and kept in a phial closely stopped, will emit a beautiful white light in the dark, after having been exposed some time to the rays of the sun. At present no use is made of this salt, except for drying some of the gases by attracting their moisture; but it might be employed instead of the nitrate of potash for manufacturing aqua fortis.

The nitrate of ammonia possesses the property of exploding, and being totally decomposed, at the temperature of 600°; whence it acquired the name of nitrum flammans. The readiest mode of preparing it, is by adding carbonate of ammonia to dilute nitric acid till saturation takes place. If this solution be evaporated in a heat between 70° and 100°, and the evaporation not carried too far, it crystallizes in hexaëdral prisms terminating in very acute pyramids; if the heat rise to 212°, it will afford, on cooling, long fibrous silky crystals: if the evaporation be carried so far as for the salt to concrete immediately on a glass rod by cooling, it will form a compact mass. According to Mr. Davy, these differ but little from each other, except in the water they contain, their component parts being as follows:

	contains of acid	ammonia	water
Prismatic	69.5	18.4	12.1
Fibrous	72.5	19.3	8.2
Compact	74.5	19.8	5.7

All these are completely deliquescent, but they differ a little in solubility. Alcohol at 176° dissolves nearly 90.9 of its own weight.

The chief use of this salt is for affording nitrous oxide on being decomposed by heat. See nitrous oxide, under the art. GAS.

Nitrate of magnesia, magnesian nitre, crystallizes in four-sided rhomboidal prisms, with oblique or truncated summits, and sometimes in bundles of small needles. Its taste is bitter, and very similar to that of nitrate of lime, but less pungent. It is fusible, and decomposable by heat, giving out first a little oxygen gas, then nitrous oxide, and lastly nitric acid. It deliquesces slowly. It is soluble in an equal weight of cold water, and in but little more hot, so that it is scarcely crystallizable but by spontaneous evaporation.

The two preceding species are capable of combining into a triple salt, an ammoniaco-magnesian nitrate, either by uniting the two in solution, or by a partial decomposition of either by means of the base of the other. This is slightly inflammable when suddenly heated: and by a lower heat is decomposed, giving out oxygen, azote, more water than it contained, nitrous oxide, and nitric acid. The residuum is pure magnesia. It is disposed to attract moisture from the air, but is much less deliquescent than either of the salts that compose it; and requires eleven parts of water at 60° to dissolve it. Boiling water takes up more, so that it will crystallize by cooling. It consists of 78 parts of nitrate of magnesia and 22 of nitrate of ammonia.

From the activity of the nitric acid as a solvent of earths in analyzation, the nitrate of glucine is better known than any other of the salts of this new earth. Its form is either pulverulent, or a tenacious or ductile mass. Its taste is at first saccharine, and afterward astringent. It grows soft by exposure to heat, soon melts, its acid is decomposed into oxygen and azote, and its base alone is left behind. It is very soluble and very deliquescent.

Nitrate, or rather supernitrate, of alumine, crystallizes, though with difficulty, in thin, soft, pliable flakes. It is of an austere and acid taste, and reddens blue vegetable colours. It may be formed by dissolving in diluted nitric acid, with the assistance of heat, fresh precipitated alumine, well washed but not dried. It is deliquescent, and soluble in a very small portion of water. Alcohol dissolves its own weight. It is easily decomposed by heat.

Nitrate of zircone was first discovered by Klaproth, and has since been examined by Guyton-Morveau and Vauquelin. Its crystals are small, capillary, silky needles. Its taste is astringent. It is easily decomposed by fire, very soluble in water, and deliquescent. It may be prepared by dissolving zircone in strong nitric acid; but like the preceding species, the acid is always in excess.

Nitrate of ittria may be prepared in a similar manner. Its taste is sweetish, and astringent. It is scarcely to be obtained in crystals; and if it be evaporated by too strong a heat, the salt becomes soft like honey, and on cooling concretes into a stony mass. Exposed to the air it deliquesces.

NITRITES. Though these salts are composed of nitrous acid and certain bases, yet the only way of obtaining them is by exposing a nitrate to a pretty strong heat, till a quantity of the oxygen gas is disengaged from it: what remains is a nitrite. These salts have never been minutely examined; but it is inferred, from the experiments that have been made, that they are, in general, deliquescent, very soluble in water, decomposable by heat, and by exposure to the air they are gradually converted into nitrates by absorbing oxygen.

NITROGEN. See ATMOSPHERE; also GAS.

NITROUS *acid.* It has already been observed, that there is no such thing, properly speaking, as nitrous acid, or the nitric base acidified with a minimum dose of oxygen; but that the nitric acid is capable of absorbing various portions of nitric oxide, with which it parts very readily, so that when in considerable quantity it gives it out in the ordinary state of the air, on mixing with which it assumes the appearance of a very red vapour. Hence it was formerly called fuming nitrous acid. It appears, however, to be capable of combining with some at least of the salifiable bases, so as to form a distinct genus of salts, that may be temed nitrites. But these cannot be formed by a direct union of their component parts; being obtainable only by exposing a nitrate to a high temperature, which expels a portion of its oxygen in the state of gas, and leaves the remainder in the state of a nitrite, if the heat be not urged so far, or continued so long, as to effect a complete decomposition of the salt. In this way the nitrates of potash and soda may be obtained, and perhaps those of barytes, strontian, lime, and magnesia. The nitrites are particularly characterized by being decomposable by all the acids except the carbonic, even by the nitric acid itself, all of which expel from it nitrous acid. We are little acquainted with any one except that of potash, which attracts moisture from the air, changes blue vegetable colours to green, is somewhat acrid to the taste, and when powdered emits a smell of nitric oxide.

NITROUS *oxide.* See GAS.

NOBILITY, a quality that ennobles, and raises a person possessed of it above the rank of a commoner. The origin of nobility in Europe is by some referred to the Goths; who, after they had seized a part of Europe, rewarded their captains with titles of honour, to distinguish them from the common people. In Britain the term nobility is restrained to degrees of dignity above knighthood; but every where else nobility and gentility are the same. The British nobility consists only of five degrees, *viz.* that of a duke, marquis, earl or count, viscount, and baron, each of which see under their proper articles. In Britain these titles are only conferred by the King, and that by patent, in virtue of which it becomes hereditary. The privileges of the nobility are very considerable, they are all esteemed the King's hereditary counsellors, and are privileged from all arrests, unless for treason, felony, breach of peace, condemnation in parliament, and contempt of the king. They enjoy their seats in the House of Peers by descent, and no act of parliament can pass without their concurrence: they are the supreme court of judicature, and even in criminal cases give their verdict upon their honour, without being put to their oath. In their absence they are allowed a proxy to vote for them, and in all places of trust are permitted to constitute deputies, by reason of the necessity the law supposes them under of attending the King's person; but no peer is to go out of the kingdom without the King's leave, and when that is granted, he is to return with the King's writ, or forfeit goods and chattels.

NOBLE, a money of account containing six shillings and eight-pence. The noble was anciently a real coin struck in the reign of Edward III. and then called the penny of gold; but it was afterwards called a rose noble, from its being stamped with a rose.

NOCTURNAL, something relating to the night, in contradistinction to diurnal.

NOCTURNAL *arch*, in astronomy, the arch of a circle described by the sun, or a star, in the night.

NOCTURNAL, *semi, arch of the sun*, is that portion of a circle he passes over between the lower part of our meridian and the point of the horizon, wherein he arises; or between the point of the horizon wherein he sets, and the lower part of our meridian.

Nocturnal, or Nocturlabium, an instrument chiefly used at sea, to take the altitude or depression of some stars about the pole, in order to find the latitude and hour of the night. Some nocturnals are hemispheres, or planispheres, on the plane of the equinoctial. Those commonly in use among seamen are two; the one adapted to the polar star, and the first of the guards of the little bear; the other to the pole-star, and the pointers of the great bear.

This instrument consists of two circular plates applied to each other. The greater, which has a handle to hold the instrument, is about two inches and a half diameter, and is divided into twelve parts, agreeing to the twelve months, and each month subdivided into every fifth day; and so as that the middle of the handle corresponds to that day of the year wherein the star here regarded has the same right ascension with the sun. If the instrument be fitted for two stars, the handle is made moveable. The upper left circle is divided into twenty-four equal parts for the twenty-four hours of the day, and each hour sub-divided into quarters. These twenty-four hours are noted by twenty-four teeth to be told in the night. Those at the hours twelve, are distinguished by their length. In the centre of the two circular plates is adjusted a long index, moveable upon the upper plate. And the three pieces, *viz.* the two circles and index, are joined by a rivet which is pierced through the centre with a hole, through which the star is to be observed.

"To use the Nocturnal," turn the upper plate till the long tooth, marked twelve, be against the day of the month on the under plate: then, bringing the instrument near the eye, suspend it by the handle with the plane nearly parallel to the equinoctial; and viewing the pole-star through the hole of the centre, turn the index about till, by the edge coming from the centre, you see the bright star or guard of the little bear (if the instrument be fitted to that star): then that tooth of the upper circle, under the edge of the index, is at the hour of the night on the edge of the hour circle: which may be known without a light, by counting the teeth from the longest, which is for the hour twelve.

NODE, in surgery, a tumor arising on the bones, and usually proceeding from some venereal cause; being much the same with what is otherwise called exostosis.

NODES, in astronomy, the two points wherein the orbit of a planet intersects the ecliptic, whereof the node, where the planet ascends northwards, above the plane of the ecliptic, is called the ascending node, the northward node, and the head of the Dragon, and is marked thus ☊; the other node, where the planet desends to the south, is called the descending node, the southward node, or the Dragon's tail, marked thus ☋.

The line wherein the two circles intersect, is called the line of nodes. It appears from observation, that the line of the nodes of all the planets constantly changes its place, and shifts its situation from east to west, contrary to the order of the signs; and that the line of the Moon's nodes, by a retrograde motion, finishes its circulation in the compass of nineteen years; after which time, either of the nodes having receded from any point of the ecliptic, returns to the same again; and when the Moon is in the node, she is also seen in the ecliptic. If the line of nodes were immoveable, that is, if it had no other motion than that whereby it is carried round the Sun, it would always look to the same point of the ecliptic, or would keep parallel to itself, as the axis of the earth does.

From what has been said, it is evident that the Moon can never be observed precisely in the ecliptic, but twice in every period; that is, when she enters the nodes. When she is at her greatest distance from the nodes, *viz.* in the points, she is said to be in her limits. The Moon must be in or near one of the nodes, when there is an eclipse of the Sun or Moon.

NOLANA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoleæ, or Luridæ. Borragineæ, Jussieu. Essential character: corolla bell-shaped; style among the germs; seeds five, berried, two-celled. There is but one species, *viz.* N. protrasta, trailing nolana.

NOLLE *prosequi*, is used where the plaintiff will proceed no further in his action, and may be as well before as after a verdict, and is stronger against the plaintiff than a nonsuit, which is only a default in appearance; but this is a voluntary acknowledgment that he has no cause of action. In criminal cases it can only be entered by the Attorney General.

NOLLET (John Anthony), in biography, a French ecclesiastic and celebrated natural philosopher in the eighteenth century, was born at Pimprè, in the diocese of Noyon, in the year 1700. His parents, who

were persons of reputable character, though of humble fortunes, as they could not make him wealthy, determined to bestow on him the advantages of a good education. With this view they sent him to the college of Clermont in the Beauvoisin, and afterwards to Beauvais, where he laid a good foundation of grammar learning, which encouraged them to send him to Paris, in order to go through a course of philosophy at that university. It was their wish that he should embrace the ecclesiastical profession, and young Nollet adopted without repugnance the choice which they made for him. From a very early age he had shewn a taste for the study of natural philosophy, which had not yet become his ruling passion; he was, therefore, enabled to check himself in a pursuit which was likely to interfere with the studies more appropriate to his destined character, and gave himself up entirely to the study of scholastic theology. Having completed his academical course, and passed with reputation through the usual examinations, in 1728 he was admitted to deacon's orders, and soon became a licensed preacher. This new occupation, however, did not wholly divert his attention from the subjects of his early inquiries, and they insensibly claimed more and more of his time. At length his inclination for the sciences became irresistible, and he gave himself up to the study of natural philosophy with an ardour to which the kind of privation in which he had so long lived gave augmented force. It was now his good fortune to become known to M. du Fay and M. Reaumur, and under their instructions his talents were rapidly developed. By the former he was received as an associate in his electrical researches: and the latter resigned to him his laboratory. He was also received into a Society of Arts, established at Paris under the protection of the Count de Clermont. In the year 1734, he accompanied M. M. du Fay, du Hamel, and de Jussieu, on a visit to England, where he had the honour of being admitted a foreign member of the Royal Society, and he profited so well of this visit, as to institute a friendly and literary correspondence with some of the most celebrated men in this country. Two years afterwards he made a tour to Holland, where he formed an intimate connection with s'Gravesande and Musschenbroek. Upon his return to Paris, he resumed a course of experimental philosophy, which he commenced in 1735, and which he continued to the year 1760. These courses of experimental physics gave rise to the adoption of similar plans in other branches of science, such as chemistry, anatomy, natural history, &c.

In the year 1738, the Count de Maurepas prevailed upon Cardinal Fleury to establish a public professorship of experimental philosophy at Paris, and the Abbé Nollet was the first person who received that appointment. During the following year, the Royal Academy of Sciences appointed him adjunct mechanician to that body; and in 1742 he was admitted an associate. In the year 1739, the King of Sardinia being desirous of establishing a professorship of physics at Turin, gave an invitation to the Abbé Nollet to perform a course of experimental philosophy before the royal family, with which he complied. From Turin he took a tour to Italy, where he collected some good observations concerning the natural history of the country. In the year 1744, he had the honour of being called to Versailles, to give lessons in natural philosophy to the Dauphin, at which the King and royal family were frequently present. By the excellence and amiableness of his personal character, as well as by his scientific talents, he recommended himself to the confidence of his illustrious pupil, who continued as long as he lived to express the greatest esteem for our philosopher. It is to be lamented that his liberality did not prompt him to better the mediocrity of his tutor's fortune. In the year 1749, the Abbé Nollet took a second journey into Italy, whence wonderful accounts had been circulated throughout Europe, of the communication of medicinal virtues by electricity, which seemed to be supported by numerous well-attested facts. To examine into these facts, and to be assured of their truth or fallacy, was one grand motive with our author in passing the Alps at this time, and in visiting the gentlemen who had published any accounts of those experiments. But though he engaged them to repeat their experiments in his presence, and upon himself, and though he made it his business to get all the information which he could concerning them, he was soon convinced that the pretended facts were deceptions or exaggerations, and that no method had been discovered, by means of which the power of medicine could by electricity be made to insinuate itself into the human body. But these wonders were not the only objects which engaged our Abbe's attention in this visit to Italy; for his inquiries were extend-

ed to all the branches of natural philosophy, the arts, agriculture, &c. On his return to France, through Turin, the King of Sardinia made him an offer of the order of St. Maurice, which he thought it his duty to decline, not having the permission of his own sovereign for accepting it. In the year 1753, the King established a professorship of experimental philosophy at the Royal College of Navarre, and nominated the Abbé Nollet to fill that post. In the year 1757, the King bestowed on him the brevet of master of natural philosophy and natural history to the younger branches of the royal family of France; and in the same year appointed him professor of natural philosophy to the schools of artillery and engineers. Soon after this last preferment, he was received a pensionary of the Royal Academy of Sciences. This celebrated and laborious natural philosopher died in 1770, in the seventieth year of his age, regretted by the enlightened public, as well as the numerous friends whose attachment he had secured by the amiableness of his manners and the goodness of his heart; and more especially regretted by his poor relations, to whose relief and comfort he always paid the most affectionate attention. Besides the Royal Society of London, and the Royal Academy of Sciences at Paris, he was a member of the Institute of Bologna, the Academy of Sciences at Erfurt, and other philosophical societies and academies.

In addition to a multitude of papers inserted in the different volumes of the "Memoirs of the Academy of Sciences," from the year 1740 to the year 1767, both inclusive, the Abbé Nollet was the author of "Lessons on Experimental Philosophy," in six volumes, 12mo. "A Collection of Letters on Electricity," 1753, in three volumes, 12mo. "Enquiries into the particular Causes of Electric Phenomena," 12mo.: and "The Art of making Philosophical Experiments," in three volumes, 12mo. From the articles just enumerated, as well as an anecdote already related in his life, it appears that Abbè Nollet paid particular attention to the study of electricity; and it must be acknowledged, notwithstanding the mistakes which he fell into upon the subject, that his indefatigable industry and curious experiments contributed materially to the improvement of that science. The theory of Affluences and Effluence of this philosopher, which gained considerable attention in his time, may be seen in Priestley's Electricity.

NO-*man's-land*, a space in midships, between the after-part of the belfry and the fore-part of a boat, when she is stowed upon the booms, as in a deep waisted vessel. These booms are laid upon the forecastle nearly to the quarter-deck, where their after-ends are usually sustained by a frame, called the gallows, which consists of two strong posts, about six feet high, with a cross piece reaching from one to the other athwart ships, and serving to support the ends of those booms, masts, and yards, which lie in reserve to supply the place of others carried away, &c. The above-named space is used to contain any blocks, ropes, tackles, &c. which may be necessary on the forecastle, and probably derives the name of no-man's-land from its situation, as being neither on the starboard nor larboard side of the ship, nor on the waist nor forecastle; but being situated in the middle, partakes equally of all those places.

NOMENCLATURE, a catalogue of several of the more usual words in any language, with their significations, compiled in order to facilitate the use of such words, to those who are to learn the tongue: such are our Latin, Greek, French, &c. nomenclatures.

NOMINATIVE, in grammar, the first case of nouns which are declinable. The simple position or laying down of a noun, or name, is called the nominative case; yet it is not so properly a case as the matter or ground whence the other cases are to be formed, by the several changes and inflections given to this first termination. Its chief use is to be placed in discourse before all verbs, as the subject of the proposition or affirmation.

NONAGISMAL, in astronomy, the 90th degree of the ecliptic, reckoned from the eastern term, or point. The altitude of the nonagesimal is equal to the angle of the east, and, if continued, passes through the poles of the ecliptic; whence the altitude of the nonagesimal at a given time, under a given elevation of the pole, is easily found. If the altitude of the nonagesimal be substracted from 90°, the remainder is the distance of the nonagesimal from the vertex.

NONAGON, in mathematics, a figure having nine sides and angles. In a regular nonagon, or that the sides and angles of which are equal, if each side be 1, its area will be 6.182 nearly $= \frac{4}{9}$ of the tangent of 70° to the radius.

NON *claim*, in law, where a person has a

demand upon another, and does not enforce his claim within a reasonable time, he is precluded by law from bringing his action to enforce it; and where a creditor neglects to make his claim upon a bankrupt's estate within a certain period, he will not be let in afterwards, so as to disturb the dividend, and may lose his estate. Non-claim is generally applied to the period of five years, after which a party is barred by a fine. See LIMITATION.

NON *est factum*, is a plea where an action is brought upon a bond, or any other deed, and the defendant denies it to be his deed whereon he is impleaded. In every case where the bond is void, the defendant may plead *non est factum;* but where a bond is voidable only, he must shew the special matter.

NON *pros*, if the plaintiff in an action at law neglect to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults, against the rules of law, in any subsequent stage of the action, he is adjudged not to pursue his remedy as he ought; and thereupon a nonsuit, or *non prosequitur*, is entered, and he is then said to be non prosed.

NON *residence*, is applied to those spiritual persons who are not resident, but absent themselves for the space of one month together, or two months at several times in one year, from their dignities or benefices, which is liable to the penalties, by the statute against non-residence, 21 Henry VIII. c. 13. But chaplains to the King, or other great persons mentioned in this statute, may be non-resident on their livings; for they are excused from residence whilst they attend those who retain them.

NON *suit*, where a person has commenced an action, and at the trial fails in his evidence to support it, or has brought a wrong action. There is this advantage attending a non-suit, that the plantiff, though he pays costs, may afterwards bring another action, for the same cause; which he cannot do, after a verdict against him.

NONCONFORMISTS, the same with dissenters. See DISSENTERS.

NONES, in the Roman calendar, the fifth day of the months January, February, April, June, August, September, November, and December; and the seventh of March, May, July, and October. March, May, July, and October, had six days in their nones; because these alone, in the ancient constitution of the year by Numa, had thirty-one days a piece, the rest having only twenty-nine, and February thirty: but when Cæsar reformed the year, and made other months contain thirty-one days, he did not allot them six days of nones.

NORMAL, in geometry, signifies the same with a perpendicular, and is used for a line or plane that intersects another perpendicularly.

NORROY, that is *North Roy*, Northern King, in heraldry, the title of the third of the three kings at arms, or provincial heralds. His jurisdiction lies on the north side of the Trent, whence his name; as Clarencieux, on the south.

NOSE, the primary organ of smelling. See ANATOMY.

NOSTOCK, the name of a vegetable substance which seems to differ from almost all others of the same kind. It is of a greenish colour, partly transparent, and of a very irregular figure. It trembles at the touch, like jelly, but does not melt like that. It is found in all sorts of soils, but most frequently in sandy ones, sometimes on the gravel of garden walks, usually after rain in the summer months.

NOSTRILS, in anatomy, the two apertures or cavities of the nose, through which the air passes, and which serve to convey odours, and to carry off the pituita separated in the sinuses of the base of the cranium.

NOT *guilty*, is the general issue or plea of the defendant in any criminal action or prosecution; as also in an action of trespass, or upon the case for deceits and wrongs; but not on a promise or assumpsit. It is the usual defence where the party complains of a wrongful injury done to him.

NOTARY, is a person duly appointed to attest deeds and writings; he also protests and notes foreign and inland bills of exchange, and promissory notes, translates languages, and attests the same, enters and extends ship's protests, &c.

NOTATION, in arithmetic and algebra, the method of expressing numbers or quantities by signs or characters, appropriated for that purpose. See ARITHMETIC.

There is one thing which deserves particular notice, in regard to this subject, and that is, the great advantages that may redound to science, by a happy notation, or expression of our thoughts. It is owing entirely to this, and the method of denoting the several combinations of numbers, by figures standing in different places, that the most complicated operations in arithmetic are managed with so much ease and dispatch. Nor is it less apparent that the

discoveries made by algebra are wholly to be imputed to that symbolical language made use of in it: for by this means we are enabled to represent things in the form of equations: and by variously proceeding with these equations, to trace out, step by step, the several particulars we want to know. Add to all this, that by such a notation, the eyes and imagination are also made subservient to the discovery of truth; for the thoughts of the mind rise up and disappear, according as we set ourselves to call them into view; and, therefore, without some particular method of fixing and ascertaining them as they occur, the retrieving them when out of sight would be no less painful, than the very first exercise of deducing them one from another. As, therefore, we have frequent occasion to look back upon the discoveries already made, could these be no otherwise brought into view, than by the same course of thinking in which they were first traced, so many different attentions at once must needs greatly distract the mind, and be attended with infinite trouble and fatigue. But now, the method of fixing and ascertaining our thoughts by a happy and well chosen notation, entirely removes all those obstacles; for thus, when we have occasion to turn to any former discovery, as care is taken all along to delineate them in proper characters, we need only cast our eye on that part of the process where they stand expressed, which will lay them at once open to the mind in their true and genuine form. By this means we can take, at any time, a quick and ready survey of our progress, and running over the several conclusions already gained, see more distinctly what helps they furnish towards obtaining those others we are still in pursuit of. Nay, further, as the amount of every step of the investigation lies before us, by comparing them variously among themselves, and adjusting them one to another, we come at length to discern the result of the whole, and are enabled to form our several discoveries into an uniform and well-connected system of truths, which is the end and aim of all our inquiries.

NOTES, in music, characters which mark the sounds; *i. e.* the elevations and fallings of the voice, and the swiftness and slowness of its motions. In general, under notes are comprehended all the signs or characters used in music, though in propriety the word only implies the marks which denote the degrees of gravity and acuteness to be given to each sound.

NOTONECTA, in natural history, *boat-fly*, a genus of insects of the order Hemiptera. Snout inflected; antennæ shorter than the thorax; four wings folded cross-wise, coriaceous on the upper half; hind-legs hairy, formed for swimming. There are seventeen species in two divisions, *viz.* A. Lip elongated, conic. B. Conic, spinous at the sides. Mr. Donovan in his English insects has described N. clauca: upper wings yellow-brown, the anterior margin bright-brown dotted with black, the tip bifid. It is found in Europe.

NOTOXUS, in natural history, a genus of insects of the order Coleoptera. Antennæ filiform; four feelers, hatchet-shaped; jaw one-toothed; thorax a little narrowed behind. There are about thirteen species. N. moneceros, described in Donovan's insects, has a thorax projecting like a horn over the head; shells pale, with a black band and dot. It inhabits Europe on umbelliferous plants.

NOVEL, in the civil law, a term used for the constitutions of several emperors, as of Justin, Tiberius, Leo, and more particularly of those of Justinian. The constitutions of Justinian were called novels, either from their producing a great alteration in the face of the ancient law, or because they were made on new cases, and, after the revisal of the ancient code, compiled by order of that emperor. Thus the constitutions of the emperors Theodosius, Valentinian, Marcian, &c. were also called novels, on account of their being published after the Theodosian code.

NOVEL *assignment*, or new assignment, a term in law pleadings which it is difficult to explain to those unacquainted with practical pleading. It occurs in actions of trespass, where the form of the declaration being very general, the defendant pleads in bar a common justification; to which the plaintiff replies by stating, that he brought his action as well for a certain other trespass which he states with more particularity, as for that which is justified. This is called a new assignment.

NOVEMBER, in chronology, the 11th month of the Julian year, consisting only of thirty days: it got the name of November, as being the ninth month of Romulus's year, which began with March.

NOUN, in grammar, a part of speech, which signifies things without any relation

to time; as a man, a house, sweet, bitter, &c. See GRAMMAR.

NOURISHMENT. See PHYSIOLOGY.

NUDE *contract, nudum pactum*, a bare promise without any consideration, and not authenticated by deed, which is therefore void in law.

NUISANCE, signifies generally anything that does hurt, inconvenience, or damage to the property or person of another. Nuisances are of two kinds, public and private, and either affect the public or the individual. The remedy for a private nuisance is by action on the case for damages, and for a public nuisance by indictment. Amongst the nuisances which most commonly occur are the erecting of noxious manufactures in towns, and in the vicinity of ancient houses; such as the erecting a vitriol manufactory, to the annoyance of the neighbours in general. Disorderly houses, bawdy houses, stage booths, lotteries, and common scolds, are also public nuisances. Where the injury is merely to an individual, and not to the public, the individual only has an action, but not in the case of a public nuisance, where the private injury is merged, or lost, in that of the public, but where an individual receives a particular injury by a public nuisance. And any one aggrieved may abate, that is, pull down and remove a nuisance, after which he can have no action: but this is a dangerous attempt to take the law into one's own hands. It must be done without riot, if at all. Every continuance of a nuisance is a fresh nuisance, and a fresh action will lie.

NUL *tiel record*, no such record in law, is the replication which the plaintiff makes to the defendant when the latter pleads a matter of record in bar to the action, and it is necessary to deny the existence of such record, and to join issue on that fact.

NUMBER, a collection of several units, or of several things of the same kind, as 2, 3, 4, &c. Number is unlimited in respect of increase, because we can never conceive a number so great, but still there is a greater. However, in respect of decrease it is limited; unity being the first and least number, below which therefore it cannot descend.

NUMBERS, *kinds and distinctions of*. Mathematicians, considering number under a great many relations, have established the following distinctions. Broken numbers, are the same with fractions. See ARITHMETIC. Cardinal numbers, are those which express the quantity of units, as 1, 2, 3, 4, &c.; whereas ordinal numbers, are those which express order, as 1st, 2d, 3d, &c. Compound number, one divisible by some other number besides unity; as 12, which is divisible by 2, 3, 4, and 6. Numbers, as 12 and 15, which have some common measure besides unity, are said to be compound numbers among themselves. Cubic number, is the product of a square number by its root: such is 27, as being the product of the square number 9, by its root 3. All cubic numbers whose root is less than 6, being divided by 6, the remainder is the root itself: thus $27 \div 6$ leaves the remainder 3, its root; 216, the cube of 6, being divided by 6, leaves no remainder; 343, the cube of 7, leaves a remainder 1, which, added to 6, is the cube root; and 512, the cube of 8, divided by 6, leaves a remainder 2, which added to 6, is the cube root. Hence the remainders of the divisions of the cubes above 216, divided by 6, being added to 6, always gives the root of the cube so divided, till that remainder be 5, and consequently 11, the cube root of the number divided. But the cubic numbers above this being divided by 6, there remains nothing, the cube root being 12. Thus the remainders of the higher cubes are to be added to 12, and not to 6; till you come to 18, when the remainder of the division must be added to 18; and so on *ad infinitum*. From considering this property of the number 6, with regard to cubic numbers, it has been found that all other numbers, raised to any power whatever, had each their divisor, which had the same effect with regard to them that 6 has with regard to cubes. The general rule is this: "If the exponent of the power of a number be even, that is, if that number be raised to the 2d, 4th, 6th, &c. power, it must be divided by 2; then the remainder added to 2, or to a multiple of 2, gives the root of the number corresponding to its power, that is the 2d, 4th, and root. But if the exponent of the power of the number be uneven, the 3d, 5th, 7th power, the double of that exponent is the divisor that has the property required.

Determinate number, is that referred to some given unit, as a ternary or three: whereas an indeterminate one, is that referred to unity in general, and is called quantity. Homogeneal numbers, are those referred to the same unit; as those referred to different units are termed heterogeneal. Whole numbers are otherwise called integers. Rational number, is one commensu-

rable with unity; as a number, incommensurable with unity, is termed irrational or a surd. See SURD. In the same manner a rational whole number is that whereof unity is an aliquot part; a rational broken number, that equal to some aliquot part of unity; and a rational mixed number, that consisting of a whole number and a broken one. Even number, that which may be divided into two equal parts without any fraction, as 6, 12, &c. The sum, difference, and product of any number of even numbers, is always an even number. An evenly even number, is that which may be measured, or divided, without any remainder, by another even number, as 4 by 2. An unevenly even number, when a number may be equally divided by an uneven number, as 20 by 5. Uneven number, that which exceeds an even number, at least by unity, or which cannot be divided into two equal parts, as 3, 5, &c. The sum or difference of two uneven numbers make an even number; but the factum of two uneven ones make an uneven number. If an even number be added to an uneven one, or if the one be subtracted from the other, in the former case the sum, in the latter the difference, is an uneven number; but the factum of an even and uneven number is even. The sum of any even number of uneven numbers is an even number; and the sum of any uneven number of uneven numbers is an uneven number. Primitive, or prime numbers, are those only divisible by unity, as 5, 7, &c. And prime numbers among themselves, are those which have no common measure besides unity, as 12 and 19. Perfect number, that whose aliquot parts added together make the whole number, as 6, 28; the aliquot parts of 6 being 3, 2, and 1, = 6; and those of 28 being 14, 7, 4, 2, 1, = 28. Imperfect numbers, those whose aliquot parts, added together, make either more or less than the whole. And these are distinguished into abundant and defective; an instance in the former case is 12, whose aliquot parts 6, 4, 3, 2, 1, make 16; and in the latter case 16, whose aliquot parts 8, 4, 2, and 1, make but 15. Plain number, that arising from the multiplication of two numbers, as 6, which is the product of 3 by 2; and these numbers are called the sides of the plane. Square number, is the product of any number multiplied by itself: thus 4, which the factum of 2 by 2, is a square number. Every square number added to its root makes an even number. Polygonal, or polygonous numbers, the sums of arithmetical progressions beginning with unity: these, where the common difference is 1, are called triangular numbers; where 2, square numbers; where 3, pentagonal numbers; where 4, hexagonal numbers; where 5, heptagonal numbers, &c. See POLYGONAL. Pyramidal numbers: the sums of polygonous numbers, collected after the same manner as the polygons themselves, and not gathered out of arithmetical progressions, are called first pyramidal numbers: the sums of the first pyramidals are called second pyramidals, &c. If they arise out of triangular numbers, they are called triangular pyramidal numbers; if out of pentagons, first pentagonal pyramidals. From the manner of summing up polygonal numbers, it is easy to conceive how the prime pyramidal numbers are found, viz. $\frac{(a-2)n^3+3n^2-(a-5)n}{6}$ expresses all the prime pyramidals.

NUMBER *of direction*, in chronology, some one of the 35 numbers between the Easter limits, or between the earliest and latest day on which it can fall; *i. e.* between the 22d of March and the 25th of April. Thus, if Easter Sunday fall as in the first line below, the number of direction will be as on the lower line.

	March.										April.			
Easter-day	22,	23,	24,	25,	26,	27,	28,	29,	30,	31.	1,	2,	3,	&c.
Number of direction	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11,	12,	13,	&c.

and so on till the number of direction and the sum will be so many days in March for the Easter-day; if the sum exceed 31, the excess will be the day of April. To find the number of direction: enter the following table with the dominical letter on the left hand, and the golden number at top; then where the columns meet is the number of direction for that year.

G. N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Dominical																			
A	29	19	5	20	12	33	19	12	26	19	5	26	12	5	26	12	33	[illegible]	12
B	27	13	6	27	13	34	20	[illegible]	27	20	6	27	[illegible]	6	20	13	34	20	[illegible]
C	8	4	7	21	14	[illegible]	[illegible]	[illegible]	28	[illegible]	7	28	14	7	21	14	28	[illegible]	7
D	19	15	8	22	15	[illegible]	[illegible]	8	[illegible]	[illegible]	8	29	[illegible]	1	22	15	[illegible]	[illegible]	8
E	30	16	2	[illegible]	[illegible]	[illegible]	[illegible]	9	30	16	9	[illegible]	16	2	23	[illegible]	9	30	9
F	24	17	3	24	10	31	24	10	31	17	10	[illegible]	17	3	24	10	31	17	10
G	25	18	4	25	11	32	18	11	32	18	4	25	[illegible]	4	25	11	32	18	11

Thus, for the present year, 1808, the dominical letter being B, and the golden number 4, we find the number of direction 27, to which add 21, and the sum is 48 from the 1st of March; deduct 31 for the number of days in March, and the remainder gives the day of April for Easter Sunday.

NUMBER, *golden*, in chronology. See GOLDEN *number*.

NUMBER, in grammar, a modification of nouns, verbs, &c. to accommodate them to the varieties in their objects, considered with regard to number. See GRAMMAR.

NUMBERS, in poetry, oratory, music, &c. are certain measures, proportions, or cadences, which render a verse, period, or song, agreeable to the ear.

NUMERAL *letters*, those letters of the alphabet which are generally used for figures, as I, V, X, L, C, D, M.

NUMERATION, or *notation*, the art of expressing in characters any number proposed in words; or of expressing in words any number proposed in characters. See ARITHMETIC; NOTATION.

NUMERICAL, or NUMERAL, something belonging to numbers; as numerical algebra is that which makes use of numbers instead of letters of the alphabet. Also, numerical difference is the difference whereby one individual is distinguished from another. Hence a thing is said to be numerically the same, when it is so in the strictest sense of the word.

NUMIDIA, the PINTADO, or *guinea-hen*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill strong and short, with a carunculate cere at the base, in which the nostrils are lodged; head horned with a compressed coloured callus; wattles hanging from the cheeks; tail short, and pointing downwards; body speckled. There are four species. N. meleagris, is of the size of a very large fowl, and is the meleagris of the ancients, who used to prize it as a high delicacy. Its native territory is Africa, and particularly, perhaps, Nubia. It is gregarious, having been often seen in very numerous flocks. It is now extremely common in this country. The female lays many eggs, and, secreting her nest, sometimes will suddenly appear with a family of twenty young ones. It is a bird of harsh sound, and almost perpetually uttering it. The flesh of the young birds is valued, and its eggs are thought preferable to those of the common hen. See Aves, Plate X. fig. 5.

NUNEZ (PEDRO) in biography, one of the ablest mathematicians of his time, born at Alcaza do Sal, in Portugal. He taught publicly in the university of Coimbra, and instructed the Infante de Luis so well, that it is said he fitted him for a professor. Pero Nunez is well known in the history of science, as the person who made the first improvement in the method of reading an observed angle, and the scale which he invented for this purpose, though it has received some improvements, is still called the Nonius, his latinized name. His works are numerous.

NUT-*galls* are excrescences formed on leaves of the oak by the puncture of an insect which deposits an egg on them. The best are known by the name of Aleppo-galls, imported very largely into this country for the use of dyers, calico printers, &c. These are hard like wood, of a bluish colour, and of a disagreeable taste. They are partly soluble in water, and what remains is tasteless and possesses the properties of the fibre of wood. By experiments Mr. Davy found that 500 grains of Aleppo-galls formed with water a solution which yielded by slow evaporation 185 grains of matter, which was composed of

Tannin	130
Gallic acid and extract	31
Mucilage and extract	12
Lime and saline matter	12
	185

See TANNIN.

NUTATION, in astronomy, a kind of tremulous motion of the axis of the earth, whereby, in each annual revolution it is twice inclined to the ecliptic, and as often returns to its former position.

Sir Isaac Newton observes, that the moon has the like motion, only very small, and scarcely sensible.

NUTMEG, in natural history, the kernel of a large fruit, not unlike the peach, the produce of a tree called by botanists MYRISTICA, which see.

The nutmeg is separated from its investient coat, the mace, before it is sent over to us; except that the whole fruit is sometimes imported in preserve, by way of sweetmeat, or as a curiosity. See MACE.

The nutmeg, as we receive it, is of a roundish or oval figure, of a tolerably compact and firm texture, but easily cut with a knife, and falling to pieces on a smart blow. Its surface is not smooth, but furrowed with a number of wrinkles, running in various directions, though principally longitudinally. It is of a greyish brown colour on the outside, and of a beautiful variegated hue within, being marbled with brown and yellow variegations, running in perfect irregularity through its whole substance. It is very unctuous and fatty to the touch, when powdered, and is of an extremely agreeable smell, and of an aromatic taste, without the heat that attends that kind of flavour in most of the other species.

There are two kinds of nutmeg in the shops, the one called by authors the male, and the other the female. The female is the kind in common use, and is of the shape of an olive: the male is long and cylindric, and has less of the fine aromatic flavour than the other, so that it is much less esteemed, and people who trade largely in nutmegs will seldom buy it. Besides this oblong kind of nutmegs, we sometimes meet with others of perfectly irregular figures, but mere lusus naturæ, not owing to a different species of the tree. The longer male nutmeg, as we term it, is called by the Dutch the wild nutmeg. It is always distinguishable from the others, as well by its want of fragrancy, as by its shape: it is very subject to be worm-eaten, and is strictly forbid, by the Dutch, to be packed up among the other, because it will give occasion to their being worm-eaten by the insects getting from it into them, and breeding in all parts of the parcel. The largest, heaviest, and most unctuous of the nutmegs are to be chosen, such as are the shape of an olive, and of the most fragrant smell.

NUTRITION. See PHYSIOLOGY.

NYCTANTHES, in botany, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla, salver shaped, with truncated segments; capsule, two-celled, margined; seeds solitary. There are seven species, of which N. undulata, wave-leaved Nyctanthes, is a shrub about six feet in height, the young shoots are hairy; leaves of a shining green, smooth, in pairs from the joints, bitter, without any smell; flowers white; calycine segments six; of the corolla six, seven or eight, narrow, much waved on the edge; fruit superior, resembling a black cherry, containing a round hairy seed. It is a native of the East Indies, where it is much cultivated on account of the sweetness of the flowers, which are worn by the ladies in their hair.

NYMPH, among naturalists, that state of winged-insects between their living in the form of a worm, and their appearing in the winged or most perfect state.

The eggs of insects are first hatched into a kind of worms, or maggots; which afterwards pass into the nymph-state, surrounded with shells or cases of their own skins; so that, in reality, these nymphs are only the embryo-insects, wrapped up in this covering; from whence they at last get loose, though not without great difficulty.

NYMPHÆ. See ANATOMY.

NYMPHÆA, in botany, *water-lily*, a genus of the Polyandria Monogynia class and order. Natural order of Succulentæ. Hydrocharides, Jussieu. Essential character, calyx four, five, or six leaved; corolla many petalled; berry many celled, truncated. There are six species, of which N. alba, white water-lily, has a tuberous root, creeping far and wide in the mud; the whole plant is larger than the yellow water-lily; petioles and peduncles round, within full of pores; flowers large and very handsome, petals white, from sixteen to twenty in number; stamens sixty-eight, or seventy; germ roundish; style none; stigma rayed; according to Linnæus, the flower raises itself out of the water and expands about seven o'clock in the morning, closing again, and reposing upon the surface of the water soon after four in the evening.

The roots have an astringent bitter taste;

they are used in Ireland, and in the Highlands of Scotland, to dye a dark brown or chesnut colour; this plant is a native of most parts of Europe, in slow streams, pools and ditches, flowering in July and August.

NYSSA in botany, a genus of the Polygamia Dioecia class and order. Natural order of Holoraceæ. Elæagmi, Jussieu. Essential character: calyx, five parted; corolla none: male, stamens ten: hermaphrodite, stamens five; pistil one; drupe inferior. There are two species, *viz.* N. integrifolia, mountain tupelo; and N. denticulata, water tupelo; the former of which grows naturally in Pennsylvania, rising to the height of thirty or forty feet, and nearly two in diameter, sending off many horizontal and often depending branches; leaves of a dark green colour on the upper surface, but lighter underneath; the flowers are produced upon long footstalks, from the base of the young shoots, dividing irregularly into several parts, each supporting a small flower; the female trees have fewer flowers, produced upon much longer simple cylindrical footstalks. The Virginian water tupelo tree grows naturally in wet swamps, or near large rivers in Carolina and Florida, rising with a strong upright trunk to the height of eighty or an hundred feet, dividing into many branches towards the top; the leaves are large, of an oval spear-shaped form; the berries are nearly the size and shape of small olives, and are preserved by the French inhabitants upon the Missisippi, where it abounds, and is called the olive tree.

O.

O, or o, the fourteenth letter, and fourth vowel of our alphabet, pronounced as in the words *nose*, *rose*, &c.

The sound of this letter is often so soft, as to require it double, and that chiefly in the middle of words; as *goose*, *reproof*, &c. and in some words this *oo* is pronounced like *u* short, as in *flood*, *blood*, &c.

As a numeral, O is sometimes used for eleven; and with a dash over it, thus $\overline{O}$, for eleven thousand.

In music, the O, or rather a circle, or double CO, is a note of time, called by us a semi-breve; and, by the Italians, circolo. The O is also used as a mark of triple time, as being the most perfect of all figures. See Triple.

OAK. See Quercus.

OAKUM, old ropes untwisted, and pulled out into loose hemp, in order to be used in caulking the seams, tree nails and bends of a ship, for stopping or preventing leaks.

OAR, in navigation, a long piece of wood, made round where it is to be held in the hand, and thin and broad at the other end, for the easier cutting and resisting the water, and consequently moving the vessel, by rowing.

OAT. See Avena.

OBELISK, in architecture, a truncated, quadrangular, and slender pyramid, raised as an ornament, and frequently charged either with inscriptions or hieroglyphics.

OBJECT, in philosophy, something apprehended, or presented to the mind, by sensation or by imagination.

Object *glass of a telescope, or microscope*, the glass placed at the end of the tube which is next the object.

To prove the goodness and regularity of an object-glass, on a paper, describe two concentric circles, the one having its diameter the same with the breadth of the object-glass, and the other half that diameter; divide the smaller circumference into six equal parts, pricking the points of division through with a fine needle; cover one side of the glass with this paper, and, exposing it to the sun, receive the rays through these six holes upon a plane; then by moving the plane nearer to, or further from the glass, it will be found whether the six rays unite exactly together at any distance from the glass; if they do, it is a proof of the regularity and just form of the glass; and the said distance is also the focal distance of the glass. A good way of proving the excellency of an object-glass, is by placing it in a tube, and trying it with small eye-glasses, at several distant objects; for that object-glass is always the best which represents

objects the brightest and most distinct, and which bears the greatest aperture, and the most convex and concave eye-glasses, without colouring or haziness. A circular object-glass is said to be truly centered when the centre of its circumference falls exactly in the axis of the glass; and to be ill centered when it falls out of the axis. To prove whether object-glasses be well centered, hold the glass at a due distance from the eye, and observe the two reflected images of a candle, varying the distance till the two images unite, which is the true centre point: then if this fall in the middle, or central point of the glass, it is known to be truly centered. As object-glasses are commonly included in cells that screw upon the end of the tube of a telescope, it may be proved whether they be well centered by fixing the tube and observing, while the cell is unscrewed, whether the cross-hairs keep fixed upon the same lines of an object seen through the telescope.

OBJECTIVE *line*, in perspective, is any line drawn on the geometrical plane, whose representation is sought for in a draught or picture: and the *objective plane* is any plane situated in the horizontal plane, the representation of which is required. See PERSPECTIVE.

OBLATE, flattened, or shortened, as an oblate spheroid, having its axis shorter than its middle diameter, being formed by the rotation of an ellipse about the shorter axis. The oblateness of the earth refers to the diminution of the polar axis in respect of the equatorial. The ratio of these two axis has been determined in various ways; sometimes by the measures of different degrees of latitude, and sometimes by the length of pendulums, vibrating seconds in different latitudes. See EARTH, DEGREE, &c.

OBLIGATION, in law, a bond containing a penalty, with a condition annexed, either for payment of money, performance of covenants, or the like. This security is called a specialty. See BOND and DEED.

OBLIGOR, in law, he who enters into an obligation; as obligee is the person to whom it is entered into.

OBLIQUE, in geometry, something aslant, or that deviates from the perpendicular. Thus an oblique angle is either an acute, or obtuse one, *i. e.* any angle except a right one. See ANGLE.

OBLIQUE *cases*, in grammar, are all the cases except the nominative.

OBLIQUE *line*, that which, falling on another line, makes oblique angles with it, *viz.* one acute, and the other obtuse.

OBLIQUE *planes*, in dialling, are those which recline from the zenith, or incline towards the horizon.

The obliquity, or quantity of this inclination, or reclination, may be found by means of a quadrant.

OBLIQUE *sailing*, in navigation, is when a ship sails upon some rhumb between the four cardinal points, making an oblique angle with the meridian; in which case she continually changes both latitude and longitude. Oblique sailing is of three kinds, *viz.* plain sailing, Mercator's sailing, and great circle sailing. See NAVIGATION.

OBLIQUE *sphere*, is where the pole is elevated any number of degrees less than 90°; in which case the axis of the world, the equator, and parallels of declination, will cut the horizon obliquely.

OBLIQUITY *of the ecliptic*. See ECLIPTIC.

OBLIQUUS, in anatomy, *oblique*, a name given to several muscles, particularly in the head, eyes, and abdomen. See ANATOMY.

OBOLARIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx two-leaved; corolla four-cleft, bell-shaped; stamina from the slits of the corolla; capsule one-celled, two-valved, many-seeded. There is but one species, *viz.* O. virginica.

OBSERVATION, in astronomy and navigation, is the observing with an instrument some celestial phenomenon, as the altitude of the sun, moon, and stars, or their distances from each other. But by this term, mariners commonly mean only the taking the meridian altitudes, in order to find the latitude; and the finding the latitude from such observed latitude, they call "working an observation."

OBSERVATORY, a place destined for observing the heavenly bodies: it is a building usually in form of a tower, erected on an eminence, and covered with a terrace for making astronomical observations. Most nations have had observatories, which have been noticed at large in La Lande's Astronomy: of these, the following may be mentioned:

The Greenwich Observatory, or Royal Observatory of England. This was built and endowed in the year 1676, by order of King Charles the Second, at the instance of Sir Jonas Moore, and Sir Christopher Wren; the former of these gentlemen being

Surveyor General of the Ordnance, the office of Astronomer Royal was placed under that department, in which it has continued ever since.

This observatory was at first furnished with several very accurate instruments; particularly a noble sextant of seven feet radius, with telescopic sights. And the first Astronomer Royal, or the person to whom the province of observing was first committed, was Mr. John Flamsteed; a man who, as Dr. Halley expresses it, seemed born for the employment. During fourteen years he watched the motions of the planets with unwearied diligence, especially those of the moon, as was given him in charge; that a new theory of that planet being found, shewing all her irregularities, the longitude might thence be determined. In the year 1690, having provided himself with a mural arch of near seven feet radius, made by his assistant, Mr. Abraham Sharp, and fixed in the plane of the meridian, he began to verify his catalogue of the fixed stars, which had hitherto depended altogether on the distances measured with the sextant, after a new and very different manner, viz. by taking the meridian altitudes, and the moments of culmination, or in other words, the right ascension and declination. And he was so well pleased with this instrument that he discontinued almost entirely the use of the sextant. Thus, in the space of upwards of forty years, the Astronomer Royal collected an immense number of good observations; which may be found in his "Historia Cœlestis Britannica, published in 1725; the principal part of which is the Britannic Catalogue of the fixed stars.

Mr. Flamsteed, on his death in 1719, was succeeded by Dr. Halley, and he by Dr. Bradley in 1742, and this last by Mr. Bliss in 1762; but none of the observations of these gentlemen have yet been given to the public.

On the demise of Mr. Bliss, in 1765, he was succeeded by Dr. Nevil Maskelyne, the present Astronomer Royal, whose valuable observations have been published, from time to time, under the direction of the Royal Society, in several folio volumes.

The Greenwich Observatory is found, by very accurate observations, to lie in 51° 28′ 40″ north latitude, as settled by Dr. Maskelyne, from many of his own observations, as well as those of Dr. Bradley.

The Paris Observatory was built by Louis the Fourteenth, in the Fauxbourg St. Jaques; being begun in 1664, and finished in 1672. It is a singular but magnificent building, of eighty feet in height, with a terrace at top; and here M. de la Hire, M. Cassini, &c. the King's Astronomers, have made their observations. Its latitude is 48° 50′ 14″ north, and its longitude 9′ 20″ east of Greenwich Observatory.

In the Observatory of Paris is a cave, or pit, 170 feet deep, with subterraneous passages, for experiments that are to be made out of the reach of the sun, especially such as relate to congelations, refrigerations, &c. In this cave there is an old thermometer of M. de la Hire, which stands at all times at the same height; thereby shewing that the temperature of the place remains always the same. From the top of the platform to the bottom of the cave is a perpendicular well or pit, used formerly for experiments on the fall of bodies; being also a kind of long telescopical tube, through which the stars are seen at mid-day.

Tycho Brahe's Observatory was in the little island Ween, or the Scarlet Island, between the coasts of Schonen and Zealand, in the Baltic Sea. This observatory was not well situated for some kinds of observations, particularly the risings and settings; as it lay too low, and was land-locked on all the points of the compass except three; and the land horizon being very rugged and uneven.

Pekin Observatory. Father Le Compte describes a very magnificient observatory, erected and furnished by the late Emperor of China, in his capital, at the intercession of some Jesuit missionaries, chiefly Father Verbest, whom he appointed his chief observer. The instruments here are exceedingly large; but the divisions are less accurate, and, in some respects, the contrivance is less commodious than in those of the Europeans. The chief are, an armillary zodiacal sphere of six Paris feet diameter, an azimuthal horizon six feet diameter, a large quadrant six feet radius, a sextant eight feet radius, and a celestial globe six diameter.

Bramin's Observatory at Benares, in the East Indies, which is still one of the principal seminaries of the Bramins, or priests of the original Gentoos of Hindostan. This observatory at Benares it is said was built about 200 years since, by order of the Emperor Ackbar: for as this wise prince endeavoured to improve the arts, so he wished also to recover the sciences of Hindostan, and therefore ordered that three such places

should be erected; one at Delhi, another at Agra, and the third at Benares.

Wanting the use of optical glasses, to magnify very distant, or very small objects, these people directed their attention to the increasing the size of their instruments, for obtaining the greater accuracy and number of the divisions and subdivisions in their instruments. Accordingly, the observatory contains several huge instruments of stone, very nicely erected and divided, consisting of circles, columns, gnomons, dials, quadrants, &c. some of them of 20 feet radius, the circle divided first into 360 equal parts, and sometimes each of these into 20 other equal parts, each answering to 3′, and of about two-tenths of an inch in extent. And although these wonderful instruments have been built upwards of 200 years, the graduations and divisions on the several arcs appear as well cut, and as accurately divided, as if they had been the performance of a modern artist. The execution, in the construction of these instruments, exhibits an extraordinary mathematical exactness in the fixing, bearing, fitting of the several parts, in the necessary and sufficient supports to the very large stones that compose them, and in the joining and fastening them into each other by means of lead and iron.

We have referred to this article from the EQUATORIAL, for some account of practical astronomy, and the instruments used in this branch of science.

By practical astronomy is implied the knowledge of observing the celestial bodies with respect to their position and time of the year, and of deducing from those observations certain conclusions useful in calculating the time when any proposed position of these bodies shall happen. For this purpose, it is necessary to have a room or place conveniently situated, suitably contrived, and furnished with proper astronomical instruments. It should have an uninterrupted view from the zenith down to, or even below, the horizon, at least towards the cardinal points; and for this purpose, that part of the roof which lies in the direction of the meridian, in particular, should have moveable covers, which may easily be moved, by which means an instrument may be directed to any point of the heavens between the horizon and the zenith, as well to the northward as southward. This place, called an observatory, should contain the following instruments:

I. *A Pendulum Clock*, for showing equal time. This should show time in hours, minutes, and seconds; the observer, by hearing the beats of the pendulum, may count them by his ear, while his eye is employed on the motion of the celestial object he is observing. Just before the object arrives at the position described, the observer should look on the clock and remark the time, suppose it 9 hours, 15 minutes, 25 seconds; then saying, 25, 26, 27, 28, &c. responsive to the beat of the pendulum, till he sees through the instrument the object arrived at the position expected; which suppose to happen when he says thirty-eight, he then writes down $9^h\ 15'\ 38''$ for the time of observation, annexing the particular day. If two persons are concerned in making the observation, one may read the time audibly while the other observes through the instrument, the observer repeating the last second read when the desired position happens.

II. *An Achromatic Refracting Telescope*, or a reflecting one of two feet at least in length, for observing particular phenomena. See TELESCOPE.

III. *A Micrometer* for measuring small angular distances. See MICROMETER.

IV. *A Quadrant*, for a description of which, and its several uses, we refer to the article QUADRANT. We may, however, observe, that besides Hadley's quadrant, which is described there, we have the mural quadrant, which is reckoned one of the most useful and valuable of all the astronomical instruments, and is generally fixed to the side of a stone or brick wall, and the plane of it is erected exactly in the plane of the meridian. There is also a portable astronomical quadrant, which is in high estimation, on account of its being capable of being carried to any part of the world, and put up for the purposes of observation by almost any common workman.

V. *Astronomical or Equatorial Sector*. This is an instrument for finding the difference in right ascension and declination between two objects, the distance of which is too great to be observed by the micrometer. Let A B (Plate Observatory, fig. 1.) represent an arch of a circle containing ten or twelve degrees well divided, having a strong plate, C D, for its radius, fixed to the middle of the arch at D. Let this radius be applied to the side of an axis, H F I, and be moveable about a joint fixed to it at F, so that the plane of the sector may be always parallel to the axis,

H I, which being parallel to the axis of the earth, the plane of the sector will always be parallel to the plane of some hour circle. Let a telescope, C E, be moveable about the centre, C, of the arch, A B, from one end of it to the other, by turning a screw at G, and let the line of sight be parallel to the plane of the sector. Now, by turning the whole instrument about the axis, H I, till the plane of it be successively directed, first to one of the stars, and then to another, it is easy to move the sector about the joint, F, into such a position, that the arch, A B, when fixed, shall take in both the stars in their passage, by the plane of it, provided the difference of their declinations does not exceed the arch, A B. Then, having fixed the plane of the sector a little to the westward of both the stars, move the telescope, C E, by the screw, G, and observe by a clock the time of each transit over the cross hairs, and also the degrees and minutes upon the arch, A B, cut by the index at each transit; then in the difference of the arches, the difference of the declinations, and by the difference of the times, we have the difference of the right ascensions of the stars. The dimensions of this instrument are these; the length of the telescope, or the radius of the sector, is two feet and a half: the breadth of the radius, near the end, C, is an inch and a half, and at the end, D, two inches: the breadth of the limb, A B, is one inch and a half, and its length six inches, containing ten degrees, divided into quarters, and numbered from either end to the other.

The telescope carries a nonius, or subdividing plate, whose length being equal to sixteen quarters of a degree, is divided into fifteen equal parts, which, in effect, divides the limb into minutes, and, by estimation, into smaller parts. The length of the square axis, H I F, is eighteen inches, and of the part, H I, twelve inches; and its thickness is about a quarter of an inch. The diameters of the circles are each five inches; the thickness of the plates, and the other measures, may be taken at the direction of a workman. This instrument may be rectified for making observations in this manner: By placing the intersection of the cross hairs at the same distance from the plane of the sector as the centre of the object-glass; the plane described by the line of sight, during the circular motion of the telescope upon the limb, will be sufficiently true, or free from conical curvity, which may be examined by suspending a long plumb-line at a convenient distance from the instrument, and by fixing the plane of the sector in a vertical position; and then by observing, while the telescope is moved by the screw along the limb, whether the cross hairs appear to move along the plumb-line. The axis, *h f o*, may be elevated nearly parallel to the axis of the earth, by means of a small common quadrant, and its error may be corrected by making the line of sight follow the circular motion of any of the circumpolar stars, while the whole instrument is moved about its axis, *h f o*, the telescope being fixed to the limb; for this purpose let the telescope, *k l a*, be directed to the star *a*, when it passes over the highest point of its diurnal circle, and let the division, cut by the nonius, be noted; then, after twelve hours, when the star comes to the lowest point of its circle, having turned the instrument half round its axis, to bring the telescope into the position, *m n*; if the cross hairs cover the same star supposed at *b*, the elevation of the axis, *h f o*, is exactly right; but if it be necessary to move the telescope into the position, *u f c*, in order to point to this star at *c*, the arch, *m u*, which measures the angle *m f u*, or *b f c*, will be known; and then the axis, *h f o*, must be depressed half the quantity of this given angle if the star passed below *b*, or must be raised so much higher if above it; and then the trial must be repeated till the true elevation of the axis be obtained.

By making the like observations upon the same star on each side the pole in the six o'clock hour circle, the error of the axis, toward the east or west, may also be found and corrected, till the cross hairs follow the star quite round the pole; for supposing *a o p b c*, to be an arch of the meridian, make the angle, *a f p*, equal to half the angle, *a f c*, and the line, *f p*, will point to the pole; and if the angle, *o f p*, which is the error of the axis, will be equal to half the angle, *b f c*, or *m f u*, found by the observation; because the difference of the two angles, *a f h*, *a f c*, is double the difference of their halves, *a f o*, and *a f p*. Unless the star be very near the pole, allowance must be made for refractions. See QUADRANT.

VI. *Transit and Equal Altitude Instruments.* The transit instrument is used for observing objects as they pass over the meridian. It consists of a telescope fixed at right angles to a horizontal axis; which

axis must be so supported, that what is called the line of collimation, or line of sight of the telescope, may move in the plane of the meridian. This instrument is made of various sizes, and of large dimensions in our great observatories; but the following is one of a size sufficiently large and accurate for all the useful purposes. The axis, A B (fig. 2), to which the middle of the telescope is fixed, is about two feet and a half long, tapering gradually toward its ends, which terminate in cylinders well turned and smoothed. The telescope, C D, which is about four feet, and an inch and a half diameter, is connected with the axis by means of a strong cube or die, G, and in which the two cones, M Q, forming the axis, are fixed. This cube, G, serves as the principal part of the whole machine. It not only keeps together the two cones, but holds the two sockets, K H, of fifteen inches length, for the two telescopic tubes. Each of these sockets has a square base, and is fixed to the cube by four screws. These sockets are cut down in the sides about eight inches, to admit more easily the tube of the telescope; but when the tube is inserted, it is kept in firm by screwing up the tightening screws at the end of the sockets at K and H. These two sockets are very useful in keeping the telescope in its greatest possible degree of steadiness. They also afford a better opportunity of balancing the telescope, and rectifying its vertical thread, than by any other means. In order to direct the telescope to the given height that a star would be observed at, there is fixed a semicircle, A N, on one of the supporters, of about eight inches and a half diameter, and divided into degrees. The index is fixed on the axis, at the end of which is a vernier, which subdivides the degrees into twelve parts of five minutes. This index is moveable on the axis, and may be closely applied to the divisions by means of a tightening screw. Two upright posts of wood or stone, Y Y, firmly fixed at a proper distance, are to sustain the supporters of this instrument. These supporters are two thick brass plates, R R, having well smoothed angular notches, in their upper ends, to receive the cylindrical arms of the axis. Each of these notched plates is contrived to be moveable by a screw, which slides them upon the surfaces of two other plates immoveably fixed upon the two upright pillars; one plate moving in a horizontal, and the other in a vertical direction; or, which is more simple, these two modes are sometimes applied only on one side, as at V and P, the horizontal motion by the screw P, and the vertical by the screw V. These two motions serve to adjust the telescope to the plane of the horizon and meridian: to the plane of the horizon by the spirit-level, E F (fig. 4) hung by D C on the axis M Q, in a parallel direction, and to the plane of the meridian in the following manner: Observe by the clock when a circumpolar star seen through this instrument transits both above and below the pole; and if the times of describing the eastern and western parts of its circuit are equal, the telescope is then in the plane of the meridian: otherwise the screw, P, must be gently turned, that it may move the telescope so much that the time of the star's revolution be bisected by both the upper and lower transits, taking care at the same time that the axis remains perfectly horizontal. When the telescope is thus adjusted, a mark must be set at a considerable distance (the greater the better) in the horizontal direction of the intersection of the cross wires, and in a place where it can be illuminated in the nighttime by a lanthorn hanging near it; which mark being on a fixed object, will serve at all times afterwards to examine the position of the telescope by the axis of the instrument being first adjusted by means of the level.

To adjust the Clock by the Sun's Transit over the Meridian. Note the times by the clock when the preceding and following edges of the Sun's limb touch the cross wires. The difference between the middle time and twelve hours, shows how much the mean time, or time by the clock, is faster or slower than the apparent or solar time for that day; to which the equation of time being applied, will show the time of mean noon for that day, by which the clock may be adjusted.

The Equal Altitude Instrument, is an instrument that is used to observe a celestial object when it has the same altitude on both the east and west sides of the meridian, or in the morning and afternoon. It principally consists of a telescope about thirty inches long, fixed to a sextantal or semicircular divided arch, the centre of which is fixed to a long vertical axis.

The Equatorial or Portable Observatory, an instrument designed to answer a number of useful purposes in practical astronomy, independent of any particular observatory. It may be made use of in any steady room

or place, and performs most of the useful problems in the science. The following is a description of one lately invented by Mr. Ramsden, from whom it has received the name of the Universal Equatorial. The principal parts of this instrument (fig. 3.) are, 1. The azimuth or horizontal circle, A, which represents the horizon of the place, and moves on an axis, B, called the vertical axis. 2. The equatorial or hour circle, C, representing the equator, placed at right angles to the polar axis, D, or the axis of the earth, upon which it moves. 3. The semicircle of declination, E, on which the telescope is placed, and moving on the axis of declination, or the axis of motion of the line of collimation, F. 4. The telescope, which is an achromatic refractor with a triple object glass, whose focal distance is 17 inches, and aperture 2.45 inches, and furnished with six different eye-tubes; so that its magnifying powers extend from 44 to 168. The telescope in this equatorial may be brought parallel to the polar axis, as in the figure, so as to point to the pole star in any part of its diurnal revolution; and thus it has been observed near noon, when the sun has shone very bright. 5. The apparatus for correcting the error in altitude occasioned by refraction, which is applied to the eye-end of the telescope, and consists of a slide, G, moving in a groove or dove-tail, and carrying the several eye-tubes of the telescope, on which slide there is an index corresponding to five small divisions engraved on the dovetail; a very small circle, called the refraction circle H, moveable by a finger screw at the extremity of the eye-end of the telescope; which circle is divided into half minutes, one entire revolution of it being equal to 3′ 18″, and by its motion raises the centre of the cross hairs on a circle of altitude; and likewise a quadrant, I, of 1½ inch radius, with divisions on each side, one expressing the degree of altitude of the object viewed, and the other expressing the minutes and seconds of error occasioned by refraction, corresponding to that degree of altitude; to this quadrant is joined a small round level, K, which is adjusted partly by the pinion that turns the whole of this apparatus, and partly by the index of the quadrant; for which purpose the refraction circle is set to the same minute, &c. which the index points to on the limb of the quadrant; and if the minute, &c. given by the quadrant exceed the 3′ 18″ contained in one entire revolution of the refraction circle, this must be set to the excess above one or more of its entire revolutions; then the centre of the cross hairs will appear to be raised on a circle of altitude to the additional height which the error of refraction will occasion at that altitude. This instrument stands on three feet, L, distant from each other 14.4 inches; and, when all the parts are horizontal, is about 29 inches high: the weight of the equatorial and apparatus is only 59*lb.* avoirdupoise, which are contained in a mahogany case.

The principal adjustment in this instrument is that of making the line of collimation to describe a portion of an hour-circle in the heavens; in order to which, the azimuth circle must be truly level, the line of collimation, or some corresponding line, represented by the small brass rod M, parallel to it, must be perpendicular to the axis of its own proper motion; and this last axis must be perpendicular to the polar axis; on the brass rod, M, there is occasionally placed a hanging-level, N, the use of which will appear in the following adjustments: the azimuth circle may be made level by turning the instrument till one of the levels is parallel to an imaginary line joining two of the feet screws; then adjust that level with these two feet screws; turn the circle half round, *i. e.* 180°; and if the bubble be not then right, correct half the error by the screw belonging to the level, and the half error by the two foot screws; repeat this till the bubble comes right; then turn the circle 90° from the two former positions, and set the bubble right, if it be wrong, by the foot screw at the end of the level; when this is done, adjust the other level by its own screw, and the azimuth circle will be truly level. The hanging level must then be fixed to the brass rod by two hooks of equal length, and made truly parallel to it; for this purpose make the polar axis perpendicular or nearly perpendicular to the horizon; then adjust the level by the pinion of the declination semicircle; reverse the level, and if it be wrong, correct half the error by a small steel screw that lies under one end of the level, and the other half-error by the pinion of the declination semi-circle; repeat this till the bubble be right in both positions. In order to make the brass rod on which the level is suspended at right angles to the axis of motion of the telescope or line of collimation, make the polar axis horizontal, or nearly so; set the declination semi-circle to 0°, turn the hour circle till the bubble comes right; then turn the declination circle to

90°; adjust the bubble by raising or depressing the polar axis (first by hand till it be nearly right, afterwards tighten with an ivory key the socket which runs on the arch with the polar axis, and then apply the same ivory key to the adjusting screw at the end of the said arch till the bubble come quite right); then turn the declination circle to the opposite 90°; if the level be not then right, correct half the error by the aforesaid adjusting screw at the end of the arch, and the other half error by the two screws which raise or depress the end of the brass rod. The polar axis remaining nearly horizontal as before, and the declination semi-circle at 0°, adjust the bubble by the hour-circle; then turn the declination semicircle to 90°, and adjust the bubble by raising or depressing the polar axis; then turn the hour-circle twelve hours; and if the bubble be wrong, correct half the error by the polar axis, and the other half error by the two pair of capstan screws at the feet of the two supports on one side of the axis of motion of the telescope; and thus this axis will be at right angles to the polar axis. The next adjustment is to make the centre of cross hairs remain on the same object, while you turn the eye-tube quite round by the pinion of the refraction apparatus: for this adjustment, set the index on the slide to the first division on the dovetail; and set the division marked 18′ on the refraction circle to its index; then look through the telescope, and with the pinion turn the eye-tube quite round; and if the centre of the hairs does not remain on the same spot during that revolution, it must be corrected by the four small screws, two and two at a time (which you will find upon unscrewing the nearest end of the eye-tube that contains the first eye-glass); repeat this correction till the centre of the hairs remain on the spot you are looking at during an entire revolution.

In order to make the line of collimation parallel to the brass rod on which the level hangs, set the polar axis horizontal, and the declination circle to 90°, adjust the level by the polar axis; look through the telescope on some distant horizontal object, covered by the centre of the cross hairs; then invert the telescope, which is done by turning the hour-circle half round; and if the centre of the cross hairs does not cover the same object as before, correct half the error by the uppermost and lowermost of the four small screws at the eye-end of the large tube of the telescope; this correction will give a second object now covered by the centre of the hairs, which must be adopted instead of the first object: then invert the telescope as before; and if the second object be not covered by the centre of the hairs, correct half the error by the same two screws which were used before: this correction will give a third object, now covered by the centre of the hairs, which must be adopted instead of the second object; repeat this operation till no error remains; then set the hour-circle exactly to twelve hours (the declination circle remaining at 90° as before); and if the centre of the cross hairs does not cover the last object fixed on, set it to that object by the two remaining small screws at the eye-end of the large tube, and then the line of collimation will be parallel to the brass rod. For rectifying the nonius of the declination and equatorial circles, lower the telescope as many degrees, minutes, and seconds, below 0° or Æ on the declination semi-circle as are equal to the complement of the latitude; then elevate the polar axis till the bubble be horizontal, and thus the equatorial circle will be elevated to the co-latitude of the place; set this circle to six hours; adjust the level by the pinion of the declination circle; then turn the equatorial circle exactly twelve hours from the last position; and if the level be not right, correct one-half of the error by the equatorial circle, and the other half by the declination circle; then turn the equatorial circle back again exactly twelve hours from the last position; and if the level be still wrong, repeat the correction as before till it be right, when turned to either position; that being done, set the nonius of the equatorial circle exactly to six hours, and the nonius of the declination circle exactly to 0°. The principal uses of this equatorial are, 1. To find your meridian by one observation only; for this purpose, elevate the equatorial circle to the co-latitude of the place, and set the declination semi-circle to the sun's declination for the day and hour of the day required; then move the azimuth and hour circles both at the same time, either in the same or contrary direction, till you bring the centre of the cross hairs in the telescope exactly to cover the centre of the sun; when that is done, the index of the hour-circle will give the apparent or solar time at the instant of observation; and thus the time is gained, though the sun be at a distance from the meridian; then turn the hour-circle till the index points precisely at twelve o'clock, and

lower the telescope to the horizon, in order to observe some point there in the centre of your glass, and that point is your meridian mark found by one observation only; the best time for this operation is three hours before or three hours after twelve at noon. 2. To point the telescope on a star, though not on the meridian, in full daylight. Having elevated the equatorial circle to the co-latitude of the place, and set the declination semi-circle to the star's declination, move the index of the hour-circle till it shall point to the precise time at which the star is then distant from the meridian, found in tables of the right ascension of the stars, and the star will then appear in the glass. Besides these uses peculiar to this instrument, it is also applicable to all the purposes to which the principal astronomical instruments, *viz.* a transit, a quadrant, and an equal altitude instrument, are applied. See Vince's "Practical Astronomy."

OBSIDIAN, in mineralogy, a genus of the Pitch-stone family, found in nests in the pearl-stone of Hungary. It is common likewise in Iceland, Siberia, the Levant islands, and in South America, and has obtained the name of the Iceland agate. The principal colour is velvet-black, but it passes into greenish grey. It is often striped and spotted. The specific gravity is about 2.4: it melts into an opaque, grey mass. Specimens have been analysed, and found to contain

Silica	69	74
Alumina	22	2
Oxide of iron	9	14
	100	90
Loss		10
		100

It is on account of its great hardness and opaque blackness, and of its capability of receiving a high polish, used as an ornament in dress. In Peru, before the conquest of the country by Spain, obsidian was used as a mirror, and in Europe it has been fashioned into reflectors for telescopes.

OBTUSE, signifies blunt, dull, &c. in opposition to acute, sharp, &c.; thus we say, obtuse angle, obtuse angled triangle, &c.

OCCIDENT, in geography, the westward quarter of the horizon, or that part of the horizon where the ecliptic, or the sun therein, descends into the lower hemisphere, in contradistinction to orient.

OCCIPITAL, in anatomy, a term applied to the parts of the occiput, or back part of the skull.

OCCULT, something secret, hidden, or invisible. The occult sciences are, magic, necromancy, cabbala, &c.

Occult, in geometry, is used for a line that is scarcely perceivable, drawn with the point of the compasses, or a leaden pencil. These lines are used in several operations, as the raising of plans, designs of building, pieces of perspective, &c. They are to be effaced when the work is finished.

OCCULTATION, in astronomy, the time a star or planet is hidden from our sight, by the interposition of the body of the moon, or of some other planet.

Occultation, *Circle of perpetual*, is a parallel in an oblique sphere, as far distant from the depressed pole, as the elevated pole is from the horizon.

All the stars between this parallel and the depressed pole, never rise, but lie constantly hidden under the horizon of the place.

OCCUPANCY, in law, is a right which one acquires to a thing by being the first to gain possession of it. But this right is now chiefly done away by the English law. Formerly, if a tenant for a term of another's life died, leaving the *cestui que vie*; that is, during the life of the person for whose life the estate was held; he who first entered should hold the land during the other man's life; and he was in law called an occupant, because his title was by his first occupation. But now this title is prevented by the statutes 29 Charles II. c. 3, s. 12, and 14 George II. c. 20, s. 9, which make the estate personal assets devisable, and chargeable with the debts of the deceased, in the hands of the heir, who enters as special occupant.

OCEAN, in geography, that vast collection of salt and navigable waters, in which the two continents, the first including Europe, Asia, and Africa, and the last America, are inclosed like islands. The ocean is distinguished into three grand divisions. 1. The Atlantic Ocean, which divides Europe and Africa from America, which is generally about three thousand miles wide. 2. The Pacific Ocean, or South Sea, which divides America from Asia, and is generally about ten thousand miles over: and 3. The Indian Ocean, which separates the East Indies from Africa, which is three thousand miles over. The other seas, which are called oceans, are only parts or branches of these, and usually receive their names from

the countries they border upon. For the saltness, tides, &c. of the ocean, see the articles SEA, TIDES, &c.

OCHRES, in chemistry, combinations of earths with the oxide of iron: they are of various colours, and are principally employed as pigments.

OCHROIT, in chemistry, an earth discovered by Klaproth: the colour of the mineral in which the earth is found, and which is denominated ochroites, is between red and brown. It is compact, and breaks splintering in irregular or angular pieces. It is perfectly opaque, and the powder is of a reddish grey. The specific gravity is about 4.6. The earth was called ochroit, from the Greek word ωχρος, on account of the characteristic property which it possesses of acquiring a light brown colour after being heated. The mineral consists of

Ochroit earth	54.5
Silex	34.
Oxide of iron	4
Water	5
	97.5
Loss	2.5
	100

Ochroit earth is capable of combining with carbonic acid, during its precipitation from acids by carbonated alkalies, and strongly consolidating a portion of water. It is observed in "Nicholson's Journal," that the ochroit earth bears the nearest relation to ittria, and like that, it forms a connecting link between the earths and the metallic oxides. Like ittria, it has the property of forming a reddish-coloured salt with sulphuric acid, and is precipitable by prussiate of potash; but it differs from ittria, in that it does not form sweet salts; that it is not soluble, or at least very sparingly, in carbonate of ammonia; and that, when ignited, it acquires a cinnamon-brown colour. It differs also from ittria, by not being soluble in borax, or phosphate of soda, when urged upon charcoal before the blowpipe, which salts easily effect a solution of ittria, and melt with it also into a pellucid pearl. See ITTRIA.

OCHNA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx five-leaved; corolla five-petalled; berries one-seeded, fastened to a large, roundish receptacle. There are three species.

OCHROMA, in botany, a genus of the Monadelphia Pentandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer three-leaved; anthers connate, anfractuose; capsule five-celled, many-seeded. There is but one species, *viz.* O. lagopus, a large tree, with divaricating branches; the wood is white, tender, and sufficiently light to be used instead of corks for nets; the bark is thick, fibrous, and ash-coloured; leaves frequently a foot and half in diameter; flowers on the upper branchlets, on thick, straight peduncles; calyx greenish red; petals white, fleshy; capsule eight or ten inches long. It is a native of America.

OCHROXYLUM, in botany, a genus of the Pentandria Trigynia class and order. Essential character: calyx five-cleft; petals five; nectary an annular three-lobed gland; capsule three, approximating, one-celled, two-seeded.

OCIMUM, in botany, *basil*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx with the upper lip orbiculate, the lower four-cleft; corolla resupine, with one lip four-cleft, the other undivided; filaments, the two outer putting forth a reflex process at the base. There are twenty-five species; these are either herbs or undershrubs, possessing a sweet scent; their flowers are in whorls, forming a loose spike, terminating and axillary.

OCTAGON, in geometry, is a figure of eight sides and angles: and this, when all the sides and angles are equal, is called a regular octagon, or one which may be inscribed in a circle. If the radius of a circle, circumscribing a regular octagon, be $=r$, and the side of the octagon $=y$; then $y=\sqrt{2r^2-r\sqrt{2r^2}}$.

OCTAGON, in fortification, denotes a place that has eight bastions.

OCTAHEDRON, or OCTAEDRON, in geometry, one of the five regular bodies, consisting of eight equal and equilateral triangles. See the article BODY. The square of the side of the octahedron is to the square of the diameter of the circumscribing sphere, as 1 to 2. If the diameter of the sphere be 2, the solidity of the octahedron inscribed in it will be 1.33333, nearly. The octahedron is two pyramids put together at their bases, therefore its solidity may be found by multiplying the quadrangular base of either of them, by one-third of the per-

pendicular height of one of them, and then doubling the product.

OCTANDRIA, in botany, the eighth class in Linnæus's system, consisting of plants with hermaphrodite flowers, which are furnished with eight stamina or male organs of generation. There are four orders belonging to this class of plants which derive their names from the number of female organs possessed by the plants of each respective division.

OCTANT, or *Octile*, in astronomy, that aspect of two planets, wherein they are distant an eighth part of a circle, or 45° from each other.

OCTAVE, in music, an harmonical interval, consisting of seven degrees, or lesser intervals. See MUSIC.

OCTOBER, in chronology, the tenth month of the Julian year, consisting of thirty-one days: it obtained the name of October from its being the eighth month in the calendar of Romulus. See the articles MONTH and YEAR.

ODE, in poetry, a song, or a composition proper to be sung. Among the ancients odes signified no more than songs; but with us they are very different things. The ancient odes were generally composed in honour of their gods, as many of those of Pindar and Horace. These had originally but one stanza, or strophe, but afterwards they were divided into three parts, the strophe, the antistrophe, and the epode. The priests going round the altar singing the praises of the gods, called the first entrance, when they turned to the left, the strophe; the second, turning to the right, they called antistrophe, or returning; and, lastly, standing before the altar, they sung the remainder, which they called the epode.

OECUMENICAL, signifies the same with general, or universal; as oecumenical council, bishop, &c.

OEDERA, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyxes many-flowered; corollets tubular, hermaphrodite with one or two female ligulate florets; receptacle chaffy; down of several chaffs. There are two species, viz. O. prolifera, and O. aliena, both natives of the Cape of Good Hope.

OENANTHE, in botany, *dropwort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: florets difform; in the disk sessile, barren; fruit crowned with the calyx and pistil. There are eleven species; of which O. crocata, hemlock water dropwort, commonly grows four or five feet high, with strong jointed stalks, which being broken emit a yellowish fetid juice; the leaves are similar to those of hemlock, but of a lighter green colour; the roots divide into four or five larger taper ones, having some resemblance to parsneps, for which they have been taken. It grows naturally in several parts of Europe, on the banks of ditches, rivers, and lakes.

OENOTHERA, in botany, *tree primrose*, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four-cleft; petals four; capsule cylindrical, inferior; seeds naked. There are eleven species; of which O. biennis, broad-leaved tree primrose, has a fusiform, fibrous root; from this, the first year, arise many obtuse leaves, spreading flat upon the ground; from among these, the second year, come out the stems, three or four feet in height, upright, of a pale green colour; flowers solitary, each being separated by a leaflet, or bracte; they usually open between six and seven o'clock in the evening; for this reason the plant is called evening, or night primrose; the mode of their expanding is curious; the petals are held together at top by the hooks at the end of the calyx; the segments of which first separate at bottom, discovering the corolla, a long time before it acquires sufficient expansive force to unhook the calyx at top; when it has accomplished this, it expands almost instantaneously to a certain point, it then makes a stop, taking time to spread out quite flat; it may be half an hour from the first bursting of the calyx at bottom to the final expansion of the corolla, which commonly becomes flaccid in the course of the next day, according to the heat or coolness of the weather; the uppermost flowers appear first in June; the stalks keep continually advancing in height, and there is a constant succession of flowers till late in autumn. It is a native of North America.

OESOPHAGUS, the gula, or gullet, is a membranaceous canal, reaching from the fauces to the stomach, and conveying into it the food taken in at the mouth. Its figure is somewhat like that of a funnel, and its upper part is called by anatomists the pharynx. See ANATOMY.

OESTRUS, in natural history, *gad-fly*, a genus of insects of the order Diptera.

Mouth with a simple aperture, and not exserted; feelers two, of two articulations orbicular at the tip, and seated each side in a depression of the mouth; antennæ of three articulations, the last subglobular, and furnished with a bristle on the fore-part, placed in two hollows on the front. The face of this singular genus is broad, depressed, vesicular, and glaucous, and has some sort of resemblance to the ape kind. They are extremely troublesome to horses, sheep, and cattle, depositing their eggs in different parts of the body, and producing very painful tumours, and sometimes death. The larva are without feet, short, thick, and annulate, and often furnished with small hooks. There are twelve species, named from the animals which they infest: thus we have O. bovis, O. equi, O. ovis, O. hominis, &c. The principal European species is the O. bovis, or ox gad-fly, which is the size of a common bee, and is of a pale yellowish colour, with the thorax marked with four longitudinal dusky streaks, and the abdomen by a black bar across the middle; the lip is covered with tawny orange-coloured hairs; the wings are pale-brown, and unspotted. The female of this species, when ready to deposit her eggs, fastens on the back of a heifer, or cow, and piercing the skin with the tube situated at the lip of the abdomen, deposits an egg in the puncture, and then proceeds to another spot at some distance from the former, repeating the same operation, at intervals, on many parts of the animal's back. The pain which this operation occasions is extreme; and hence cattle, as if foreseeing their cruel enemy, are observed to be seized with the most violent horror when apprehensive of the approaches of the female oestrus, flying instantly to the nearest pond or pool of water; it having been observed that this insect rarely attacks cattle when standing in water. The eggs are laid in August or September, and the larvæ remain till the following summer before they undergo the change to the pupa state. At this period they force themselves out of their respective cells, and falling to the ground, creep beneath the first convenient shelter, and lying in an inert state become contracted into an oval form, but without casting the larva skin, which dries and hardens round them. When the included insect is ready for exclusion, it forces open the top of the pupa coat, and emerges in its perfect form, having remained within the chrysalis somewhat more than a month.

We shall give an account of the O. equi, from the Transactions of the Linnæan Society, drawn up with great accuracy by Mr. Clarke. "When the female has been impregnated, and the eggs are sufficiently mature, she seeks among the horses a subject for her purpose; and approaching it on the wing, she holds her body nearly upright in the air, and her tail, which is lengthened for the purpose, curved inwards and upwards: in this way she approaches the part where she designs to deposit her egg; and, suspending herself for a few seconds before it, suddenly darts upon it, and leaves her egg adhering to the hair: she hardly appears to settle, but merely touches the hair with the egg held out on the projected point of the abdomen. The egg is made to adhere by means of a glutinous liquor secreted with it. She then leaves the horse at a small distance, and prepares a second egg, and, poising herself before the part, deposits it in the same way. The liquor dries, and the egg becomes firmly glued to the hair: this is repeated by various flies, till four or five hundred eggs are sometimes placed on one horse. The horses, when they become used to this fly, and find that it does them no injury, as the Tabani and Conopes, by sucking their blood, hardly regard it, and do not appear at all aware of its insidious object. The skin of the horse is always thrown into a tremulous motion on the touch of this insect, which merely arises from the very great irritability of the skin and cutaneous muscles at this season of the year, occasioned by the continual teasing of the flies, till at length these muscles act involuntarily on the slightest touch of any body whatever.

"The inside of the knee is the part on which these flies are most fond of depositing their eggs, and next to this, on the side and back part of the shoulder, and, less frequently, on the extreme ends of the mane. But it is a fact worthy of attention, that the fly does not place them promiscuously about the body, but constantly on those parts which are most liable to be licked with the tongue; and the ova, therefore, are always scrupulously placed within its reach.

"The eggs thus deposited I at first supposed were loosened from the hairs by the moisture of the tongue, aided by its roughness, and were conveyed to the stomach, where they were hatched: but on more minute search I do not find this to be the case, or at least only by accident; for, when they have remained on the hairs four or five days they become ripe, after which

time the slightest application of warmth and moisture is sufficient to bring forth, in an instant, the latent larva. At this time, if the tongue of the horse touches the egg, its operculum is thrown open, and a small active worm is produced, which readily adheres to the moist surface of the tongue, and is from thence conveyed with the food to the stomach. If the egg itself be taken up by accident, it may pass on to the intestinal canal before it hatches; in which case its existence to the full growth is more precarious, and certainly not so agreeable, as it is exposed to the bitterness of the bile.

"I have often, with a pair of scissars, clipped off some hairs with eggs on them from the horse, and on placing them in the hand, moistened with saliva, they have hatched in a few seconds. At other times, when not perfectly ripe, the larva would not appear, though held in the hand under the same circumstances for several hours; a sufficient proof that the eggs themselves are not conveyed to the stomach. It is fortunate for the animal infested by these insects that their numbers are limited by the hazards they are exposed to. I should suspect near a hundred are lost for one that arrives at the perfect state of a fly. The eggs, in the first place, when ripe, often hatch of themselves, and the larva, without a nidus, crawls about till it dies; others are washed off by water, or are hatched by the sun and moisture thus supplied together. When in the mouth of the animal they have the dreadful ordeal of the teeth and mastication to pass through. On their arrival at the stomach, they may pass mixed with the mass of food into the intestines; and when full grown, in dropping from the animal to the ground, a dirty road or water may receive them. If on the commons, they are in danger of being crushed to death, or of being picked up by the birds who so constantly attend the footsteps of the cattle for food. Such are the contingencies by which nature has wisely prevented the too great increase of their numbers, and the total destruction of the animals they feed on.

"I have once seen the larva of this œstrus in the stomach of an ass; indeed there is little reason to doubt their existence in the stomachs of all this tribe of animals. These larva attach themselves to every part of the stomach, but are generally most numerous about the pylorus, and are sometimes, though much less frequently, found in the intestines. Their numbers in the stomach are very various, often not more than half a dozen, at other times more than a hundred; and, if some accounts might be relied on, even a much greater number than this. They hang most commonly in clusters, being fixed by the small end to the inner membrane of the stomach, which they adhere to by means of two small hooks, or tentacula. When they are removed from the stomach they will attach themselves to any loose membrane, and even to the skin of the hand. The body of the larva is composed of eleven segments, all of which, except the two last, are surrounded with a double row of horny bristles, directed towards the truncated end, and are of a reddish colour, except the points, which are black. The larva evidently receive their food at the small end, by a longitudinal aperture, which is situated between two hooks, or tentacula. Their food is probably the chyle, which, being nearly pure aliment, may go wholly to the composition of their bodies without any excrementitious residue, though on dissection the intestine is found to contain a yellow or greenish matter, which is derived from the colour of the food, and shows that the chyle, as they receive it, is not perfectly pure. They attain their full growth about the latter end of May, and are coming from the horse from this time to the latter end of June, or sometimes later. On dropping to the ground they find out some convenient retreat, and change to the chrysalis; and in about six or seven weeks the fly appears.

"The perfect fly but ill sustains the changes of weather; and cold and moisture, in any considerable degree, would probably be fatal to it. These flies never pursue the horse into the water. This aversion I imagine arises from the chillness of that element, which is probably felt more exquisitely by them, from the high temperature they had been exposed to during their larva state. The heat of the stomach of the horse is much greater than that of the warmest climate, being about 102 degrees of Fahrenheit, and in their fly state they are only exposed to 60, and from that to about 80 degrees. This change, if suddenly applied, would in all probability be fatal to them; but they are prepared for it by suffering its first effects in the quiescent and less sensible state of a chrysalis. I have often seen this fly, during the night-time and in cold weather, fold itself up with the head and tail nearly in contact, and lying apparently in a torpid state through the middle of the summer."

O. ovis: wings pellucid, punctured at the

base; abdomen variegated with white and black. It deposits its eggs on the inner margin of the nostrils of sheep, occasioning them to shake their heads violently, and hide their noses in the dust or gravel. The larva crawl up into the frontal sinuses, and when full fed are again discharged through the nostrils. See Pl. III. Entomology, fig. 7 and 8.

OFFENCE, is any act committed against any law. Offences are either capital, or not capital. Capital offences are those for which the offender loses his life; not capital, where the offender may lose his lands and goods, be fined, or suffer corporal punishment, or both, but which are not subject to the loss of life.

OFFERINGS. Oblations and offerings partake of the nature of tithes; and all persons who by law ought to pay their offerings, shall yearly pay to the parson, vicar, proprietary, or their deputies, or farmers of the parishes where they dwell, at such four offering days as heretofore within the space of four years last past hath been accustomed, and in default thereof shall pay for the said offerings at Easter following.

OFFICE, is that function, by virtue of which a person has some employment in the affairs of another. An office is a right to exercise any public or private employment, and to take the fees and emoluments belonging to it, whether public, as those of magistrates; or private, as of bailiffs, receivers, &c.

The statute 5 and 6 Edward VI. c. 16, declares all securities given for the sale of offices unlawful. And if any person shall bargain, or sell, or take any reward, or promise of reward, for any office, or the deputation of any office, concerning the revenue, or the keeping of the king's castles, or the administration and execution of justice, unless it be such an office as had been usually granted by the justices of the King's Bench, or Common Pleas, or by justices of assize, every such person shall not only forfeit his right to such office, or to the nomination thereof; but the person giving such reward, &c. shall be disabled to hold such office.

But it has been decided that where an office is within the statute, and the salary certain, if the principal make a deputy, reserving by bond a less sum out of the salary, it is good: or, if the profits are uncertain, reserving a part, as half the profits, it is good; for the fees still belong to the principal, in whose name they must be sued for. But where a person so appointed gives a bond to the principal to pay him a sum certain, without reference to the profits, this is void under the statute.

To offer money to any officer of state, to procure the reversion of an office in the gift of the crown, is a misdemeanor at common law, and punishable by information; and even the attempt to induce him, under the influence of a bribe, is criminal, though never carried into execution. An instance of which occurred under the administration of Mr. Addington, who prosecuted a tinman for offering a sum of money to him for a place in the customs.

Any contract to procure the nomination to an office, not within the statute 6 Edward VI. is defective on the ground of public policy; and the money agreed to be given is not recoverable.

OFFICER, a person possessed of a post or office.

The great officers of the crown, or state, are the Lord High Steward, the Lord High Chancellor, the Lord High Treasurer, the Lord President of the Council, the Lord Privy Seal, the Lord Chamberlain, the Lord High Constable, the Earl Marshall: each of which see under its proper article.

Officers, *commission*, are those appointed by the King's commission: such are all from the general to the cornet inclusive, who are thus denominated in contradistinction to warrant officers, who are appointed by the colonel's or captain's warrant, as quarter-masters, serjeants, corporals, and even chaplains and surgeons.

Officers, *field*, are such as command a whole regiment, as the colonel, lieutenant-colonel, and major.

Officers, *general*, are those whose command is not limited to a single company, troop, or regiment; but extends to a body of forces, composed of several regiments: such are the general, lieutenant-general, major-generals, and brigadiers.

Officers, *staff*, are such as, in the King's presence, bear a white staff, or wand; and at other times, on their going abroad, have it carried before them by a footman, bareheaded: such are the Lord Steward, Lord Chamberlain, Lord Treasurer, &c.

The white staff is taken for a commission, and at the King's death each of these officers breaks his staff over the hearse made for the King's body, and by this means lays down his commission, and discharges all his inferior officers.

Officers, *subaltern*, are all who administer justice in the name of subjects: as those

who act under the Earl Marshal, Admiral, &c. In the army, the subaltern officers are the lieutenants, cornets, ensigns, serjeants, and corporals.

OFFICIAL, by the ancient law, signifies him who is the minister of, or attendant upon, a magistrate. In the canon law, it is especially taken for him to whom any bishop generally commits the charge of his spiritual jurisdiction; and in this sense there is one in every diocese called *officialis principalis*, whom the laws and statutes of this kingdom call chancellor. 32 Hen. VIII. 15.

OFFING, or OFFIN, in the sea-language, that part of the sea a good distance from shore, where there is deep water, and no need of a pilot to conduct the ship: thus, if a ship from shore be seen sailing out to seaward, they say, she stands for the offing: and if a ship, having the shore near her, have another a good way without her, or towards the sea, they say, that ship is in the offing.

OFF-SETS, in gardening, are the young shoots that spring from the roots of plants; which being carefully separated, and planted in a proper soil, serve to propagate the species.

OFF-SETS, in surveying, are perpendiculars let fall, and measuring from the stationary lines to the hedge, fence, or extremity of an enclosure.

OGEE, or O. G., in architecture, a moulding, consisting of two members, the one concave and the other convex; or, of a round and a hollow, like an S.

OGIVE, in architecture, an arch, or branch of a Gothic vault; which, instead of being circular, passes diagonally from one angle to another, and forms a cross with the other arches.

OIL. The general character of oils are combustibility, insolubility in water, and fluidity. From the peculiar properties of different oils, they are naturally divided into two kinds; fixed or fat oils, and volatile or essential oils. The fixed, or fat oils, require a high temperature to raise them to the state of vapour, a temperature above that of boiling water; but the volatile, or essential oils, are volatilized at the temperature of boiling water, and even at a lower one. Both the volatile and fixed oils are obtained from plants, and sometimes from the same plant; but always from different parts of it. While the seeds yield fixed oil, the volatile oil is extracted from the bark or wood. One of the most distinguishing characteristics of the fixed oils is, that they exist only in one part of the vegetable, in the seeds. No trace of fixed oil can be detected in the roots, the stem, leaves, or flowers of those plants, whose seeds afford it in great abundance. The olive may seem an exception to this. The oil which it yields is extracted, not from the seeds, but from its covering. Among plants too, fixed oils are only found existing in those whose seeds have a peculiar structure. The seeds of plants have sometimes one lobe, in which case they are called "monocotyledonous" plants; and sometimes they have two, when they are denominated "dicotyledonous." The formation of fixed oil in plants is exclusively limited to the latter class. There is no instance of fixed oils being found in the seeds of plants which have only one lobe. Those seeds which yield the fixed oils contain also a considerable portion of mucilage, so that when such seeds are bruised and mixed with water, they form what is called an emulsion, which is a white fluid containing a quantity of the oil of the seed mixed with the mucilage. Fixed oils are extracted from the seeds of a great number of plants. Those which yield it in greatest abundance are, the olive, thence called olive oil; the seeds of lint, and the kernels of almonds, called linseed, or almond oil. Fixed oils are also obtained from animals; such as train oil, as it is called, which is extracted from the fat or blubber of the whale. Fixed oil is obtained also in great abundance from the liver of animals, and is found to exist in the eggs of fowls. These different kinds of fixed oils, although they possess many common properties, yet in others they are very different. Many of the vegetable oils have no smell, and scarcely any perceptible taste. The animal oils, on the contrary, are generally extremely nauseous and offensive. These differences are supposed to be owing to the mixture of extraneous bodies, or to certain chemical changes which arise from the action of these bodies upon each other, or on the oil itself. As the fixed oils exist ready formed in the seeds of plants, they are generally obtained by "expression," and hence they have been called "expressed oils." This is done by reducing the seeds to a kind of pulp, or paste, which is inclosed in bags, and subjected by means of machinery, when it is obtained in the large way, to strong pressure, so that the oil flows out, and is easily collected. The oil which is obtained by this process, which has been called "cold drawn oil," because it is procured without the ap-

plication of heat, and merely by pressure, is the purest; but the quantity which seeds in general yield is comparatively small, and some seeds which contain a considerable portion of oil scarcely afford any when treated in this way. It therefore becomes necessary for extracting the oil from seeds of the latter description, and to have it in greater abundance from all seeds, to employ heat to facilitate the separation of the oil from the mucilage, or other matters with which it is combined. For this purpose heat is applied, either to the apparatus which is employed in pressing out the oil, or the bruised seeds are exposed to the vapour of water, and sometimes they are boiled in the water itself; by which means those substances which are soluble in water are separated, and thus the oily part which adhered to these substances is disengaged. The oils which are obtained in this manner are very impure. They are mixed with mucilage, and other parts of the substances from which they have been extracted. Many of these matters separate from the oils when they are left at rest. They are sometimes mechanically purified by filtration through coarse cloths, by which means the grosser parts are separated. Different oils too, it is said, undergo different kinds of purification by different manufacturers, but these processes are kept secret. After they have remained at rest for some time, they are filtered and agitated with water, by which the parts that are soluble in this fluid are separated from the oil. Sometimes they are gently heated, for a shorter or longer time, according to the nature of the substances with which the oil is contaminated. Acids diluted with water are employed to separate the mucilage; lime and the alkalies are also used to combine with an acid which holds this mucilage in solution, and thus to favour its precipitation. Alum, chalk, clay, and ashes, are also employed in the purification of oils.

Fixed oils are generally liquid, but of a thick, viscid consistence, and in general they are lighter than water. The specific gravity varies from 0.91, which is that of olive oil, to 0.94, that of linseed oil. The boiling point of the fixed oils is not under the temperature of 600°. When exposed to cold they congeal, and even crystallize. There is, however, a considerable variety in this respect among fixed oils: some become solid at the temperature of a few degrees above the freezing point of water; while others, on the contrary, require a degree of cold = 5°; and some remain fluid when exposed to the greatest cold. Those oils, it has been observed, which most readily become solid, such as olive oil, are least subject to change; while those which congeal with difficulty have a greater tendency to spoil and become rancid. When fixed oil is exposed to heat it does not evaporate, till it is raised to the temperature of boiling, or 600°; but when it is thus raised in vapour its properties are changed. It is decomposed by the separation of some of its principles. The part that is volatilized has a greater proportion of hydrogen; charcoal is deposited, and water and sebacic acid are formed, while carbonated hydrogen gas is disengaged. When oil is exposed to the open air, and a burning body is brought in contact with it, it readily takes fire, and burns rapidly, with a yellowish white flame. It is on this conversion of oil into vapour, and the inflammation of this vapour, that the application of oil in lamps and candles depends. The oil is gradually and in small quantities brought in contact with the burning part of the wick; it is converted into vapour, which is immediately inflamed, and continues to burn till new portions are supplied to undergo the same change, and thus keep up a constant and uniform light and heat. According to the analysis of olive oil by Lavoisier, it is composed of hydrogen and carbon, *viz.*

Carbon	78.92
Hydrogen	21.08
	100.00

The fixed oils are insoluble in water. When it is necessary to combine them with this liquid, it is by means of mucilaginous substances, in which case the mixture is known under the name of emulsion, or with alkaline substances, when it is distinguished by the name of soap. Some of these oils become thick, opaque, white, granulated, and are analogous in appearance to tallow. Oils subject to this change are called fat oils; such, for instance, is olive oil, almond oil, and rape-seed oil. This change is more or less rapid in different circumstances. If a thin layer of oil be spread on the surface of water, and exposed to the air, it takes place in a few days, and this effect is owing to the absorption of oxygen, which combines with the oils. But other oils, when they are exposed to the air, dry altogether, yet have the property of retaining their transparency. Oils which have this peculiar property are

called drying oils. The oil of poppies, hemp-seed oil, and particularly linseed oil, are possessed of this property. The nature of the change which takes place in these drying oils is supposed to depend on the absorption of oxygen; and this oxygen combining with the hydrogen of the oil forms water. This opinion is supported by the practice which is followed to increase the drying property of linseed oil. It is usually boiled with litharge, before it is employed by painters. The litharge in this case is partly reduced to the metallic state, by being deprived of its oxygen, which is supposed to combine with the oil. Phosphorus combines with oils, with the assistance of heat. A small portion of the phosphorus is dissolved, which communicates a luminous property to the oils, so that when they are spread upon any surface they shine in the dark. Hence some twenty years ago a person exhibited in London, as the everlasting lamp of the ancients, a vessel containing phosphorus immersed in oil.

The various purposes to which fixed oils are applied, are too well known to require particular enumeration. They are employed in domestic economy, either as articles of food, and for this purpose are used alone, or in combination with other substances; or they are employed for giving light, by being burnt in lamps. They are used in medicine, either on account of the properties which peculiar oils possess, or on account of the properties they communicate to other substances with which they are combined. In this state the use of oils is well known in the form of unguents, plasters, and liniments. In the arts, fixed oils are of the most extensive utility. They are employed in the fabrication of soaps, for mixing colours in painting, for some kinds of varnish, and for defending substances from the action of air and moisture.

Volatile oils are distinguished from the fixed oils by their volatility, fragrance, and acrid taste. They are also known under the name of aromatic oils, from their odour; or essential oils, or simply essences, from being supposed to constitute the essence or the existence of the vegetable matters which furnish them. Volatile oils are not limited to particular parts of plants, but are found to exist in every part of the plant, excepting in the seed, which furnishes the fixed oils. A great number of roots, which are generally distinguished by an aromatic odour, and have more or less of an acrid taste, afford volatile oils. They are furnished also by many woods, such as those of the pine and fir tribe, and by many of those which are natives of warm climates. The leaves of a great number of plants belonging to the Didynamia class also afford volatile oil, as well as many of the umbelliferous plants. It is obtained also from many flowers of vegetables, and also from the covering of many fruits, as the skin of oranges and lemons. It is likewise obtained from a great number of seeds; but it is never found in the cotyledons or lobes themselves, but only in the external covering. The quantity of volatile oil which is obtained from vegetables, varies according to the age, the soil in which they grow, and the state of the plant. Some plants while green furnish it in greatest abundance, while others yield most when they are dry. There are two processes by which volatile oil may be obtained. When it exists in plants in great abundance, and in vesicles in a fluid state, it may be separated by mechanical means. Thus, by simple expression, the volatile oils are extracted from many plants, as, for instance, from the fruit of the orange and the lemon. From the outer rind of these fruits, when they are fresh, the volatile oil is obtained in the liquid form; but in general the volatile oils of plants are neither so abundant, nor do they exist in that state of fluidity by which they can be procured by so simple a process. In most cases they are subjected to the process of distillation; and for this purpose they are macerated for some hours in water. They are then introduced into a still with the water; a moderate heat is applied and continued till the fluid boil, when a great quantity of vapour of water, mixed with the volatile oil, passes over, and is received in proper vessels. The oil collects on the surface of the water, from which it may be easily separated. The water itself is of a milky colour, on account of a small quantity of oil suspended in it; and even after the water becomes transparent by the particles of the oil separating from it, and rising to the top, it is still loaded with the peculiar odour of the plant. The volatile oils are particularly distinguished by their fragrance, which varies in the oils extracted from different plants. The consistence of the volatile oils also varies considerably. Sometimes they are as fluid as water, which is the case with those oils obtained by expression. Some are thick and viscid, as those generally are which are extracted from woods, roots, barks, and fruits of the warmer regions. Some con-

geal, or assume a granulated solid consistence at different temperatures. Of these last some are always found to be in the concrete state. Several of the volatile oils are susceptible of crystallization, depositing in the remaining portion of the oil, which continues liquid, transparent polyhedrons, more or less of a yellow colour, which are found to be pure oil. This last change is probably owing to an incipient oxydation; for it never takes place unless oils have been kept for some time. There is great variety of colour among volatile oils. Some indeed are nearly colourless, as the oil of turpentine; but in general they are of different shades of colour. Some are yellow, as the oil of lavender; some are of a reddish yellow or brown, as the oil of cinnamon or of rhodium; some are blue, as the oil of chamomile; and some are green, as that of parsley. But the most prevailing colour among volatile oils is yellow or reddish.

Volatile oils have almost always an acrid, hot, and even burning taste. It is observed that the most acrid vegetable matters do not yield an oil possessed of this quality. The specific gravity of volatile oils is generally less than that of water. Some volatile oils, however, as those of sassafras and canella, have a greater specific gravity. The specific gravity of oils varies from 0.87 to 0.99, in those which are lighter than water; but those which are heavier are from 1.03 to 1.40. When volatile oils are exposed to the light, the colour becomes considerably deeper; they become thicker, and increase in specific gravity. When volatile oils are exposed to heat, they evaporate very readily. They are much more combustible than the fixed oils; and in burning give out a great quantity of smoke, a very bright white flame, and a good deal of heat. They require a greater proportion of oxygen than the fixed oils, and yield a greater quantity of water. This arises from a greater proportion of hydrogen, and a smaller quantity of carbon, which they contain. The volatile oils are in some degree soluble in water. When they are agitated with this liquid they combine with it, and communicate a very strong odour, and a slightly acrid taste. Phosphorus and sulphur are soluble in volatile oils. With phosphorus the solution is luminous in the dark, is extremely fetid, and gives out by the force of heat phosphorated hydrogen gas. Some of these oils are employed in medicine. They are used also for the solution of those substances which are to be employed as varnishes; and many of them are used in perfumery. As many of the volatile oils are produced but in small quantity, they are consequently high priced. There is therefore some temptation to adulterate them with fixed oils, with cheaper volatile oils, or with other substances, to increase the quantity. It is therefore of some importance to be able to detect such frauds. When a volatile oil is adulterated with a fixed oil, there is a very easy test to discover it. Let a single drop of the oil that is suspected fall on clean paper, and expose it to a gentle heat. If the oil is pure, the whole will be evaporated, and no trace remain on the paper; but if it has been mixed with a fixed oil, a greasy spot remains behind. Volatile oils are frequently adulterated with oil of turpentine; but this can only be detected by its peculiar odour, which continues for a longer time than most of the other volatile oils. When they are adulterated with alcohol, it is easily detected by mixing a little of the oil with water, which immediately produces a milkiness, by the abstraction of the alcohol from the oil, and its combination with the water. There is another class of oils, known under the name of empyreumatic oils, which have different properties from those which have been described. These oils are acrid and stimulating, with a strongly fetid and disagreeable odour. It would appear that these properties are owing to a partial decomposition of other oils. These oils are produced, as the name imports, by the action of fire. They are obtained when oils are forced to rise in vapour, and pass over in common distillation, with a greater degree of heat than that of boiling water, or by the application of a strong heat to substances from which no oil was previously extracted. These empyreumatic oils agree in some of their properties with the volatile oils. They combine in small proportion with water, and they are soluble in alcohol; and probably any difference that exists between them is owing to a partial decomposition; for when they are distilled, the oil is restored to a state of purity, and the carbonaceous matter which had been separated remains behind. See Thomson's Chemistry.

OINTMENT. See PHARMACY.

OLAX, in botany, a genus of the Triandria Monogynia class and order. Natural order of Sapotæ, Jussieu. Calyx entire; corolla funnel-form, trifid; nectarium four; berry three-celled, many-seeded. There is but one species, viz. O. Zeylanica, a native of Ceylon.

OLD *age*. See LONGEVITY.

OLDENBURG, (HENRY), in biography, who wrote his name sometimes *Grubendol*, reversing the letters, was a learned German gentleman, and born in the duchy of Bremen, in Lower Saxony, about the year 1626, being descended from the counts of Aldenburg in Westphalia; whence his name. During the long English Parliament, in the time of Charles I., he came to England as consul for his countrymen; in which capacity he remained at London in Cromwell's administration. But being discharged of that employment, he was engaged as tutor to Lord Henry O'Bryan, an Irish nobleman, whom he attended to the University of Oxford; and in 1656, he entered himself a student in that university; chiefly to have the benefit of consulting the Bodleian Library. He was afterwards appointed tutor to Lord William Cavendish, and became intimately acquainted with Milton the poet. During his residence at Oxford, he became also acquainted with the members of that society there which gave birth to the Royal Society; and upon the foundation of this latter, he was elected a member of it; and when the society found it necessary to have two secretaries, he was chosen assistant to Dr. Wilkins. He applied himself with extraordinary diligence to the duties of this office, and began the publication of the "Philosophical Transactions," with Number 1, in 1664. In order to discharge this task with more credit to himself and the Society, he held a correspondence with more than seventy learned persons, and others, upon a great variety of subjects, in different parts of the world. This fatigue would have been insupportable, had he not, as he told Dr. Lister, managed it so as to make one letter answer another; and that, to be always fresh, he never read a letter before he was ready immediately to answer it; so that the multitude of his letters did not clog him, nor ever lie upon his hands. Among others, he was a constant correspondent of Mr. Robert Boyle, and he translated many of that ingenious gentleman's works into Latin.

About the year 1674, he was drawn into a dispute with Mr. Hook, who complained, that the Secretary had not done him justice, in the History of the Transactions, with respect to the invention of the spiral spring for pocket-watches: the contest was carried on with some warmth on both sides, but was at length terminated to the honour of Mr. Oldenburg; for, pursuant to an open representation of the affair to the Royal Society, the Council thought fit to declare, in behalf of their Secretary, that they knew nothing of Mr. Hook having printed a book entitled "Lampas," &c., but that the publisher of the "Transactions" had conducted himself faithfully and honestly in managing the intelligence of the Royal Society, and given no just cause for such reflections.

Mr. Oldenburg continued to publish the "Transactions" as before, to Number 136, June 25, 1677; after which, the publication was discontinued till the January following, when they were again resumed by his successor in the secretary's office, Mr. Nehemiah Grew, who carried them on till the end of February, 1678. Mr. Oldenburg died at his house at Charlton, between Greenwich and Woolwich, in Kent, August 1678, and was interred there, being fifty-two years of age.

He published, besides what has been already mentioned, twenty tracts, chiefly on theological and political subjects; in which he principally aimed at reconciling differences and promoting peace.

OLDENLANDIA, in botany, a genus of the Tetandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx fastened to the pericarpium with four awl-shaped teeth at top; corolla one-petalled, four cleft; capsule inferior, two-celled; receptacle free, fastened to the partition by the base only. There are sixteen species.

OLEA, in botany, *olive*, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla four-cleft, with sub-ovate segments; drupe one-seeded. There are seven species, of which the O. longifolia, long-leaved European olive, is chiefly cultivated in the south of France, from which they make the best oil. O. latifolia, broad-leaved European olive, is principally cultivated in Spain, where the trees grow to a much larger size than the preceding; the fruit is nearly the size of a Provence olive; but of a stronger flavour, for which reason it is not so grateful to an English palate. The olive seldom becomes a large tree; two or three stems frequently rise from the same root, from twenty to thirty feet in height, putting out branches almost their whole length, covered with a greyish bark.

The olive, in all ages, has been held in peculiar estimation, as the bounteous gift

of Heaven; it is still considered as emblematic of peace and plenty; the great quantity of oil which it produces in some countries, effectually realizes the latter of these blessings. Unripe olives pickled, especially the Provence and Lucca sorts, are to many persons extremely grateful, they are supposed to promote digestion.

OLERON *laws*, laws relating to maritime affairs, and so called, because made when King Richard I. was at the Isle of Oleron, in Aquitaine.

OLFACTORY *nerves*, the first pair of the head; so called from their being the immediate instruments of smelling.

OLIFIANT *gas*, a name given by the Dutch chemists to carburated hydrogen, or heavy inflammable gas. See GAS.

OLIGARCHY, a form of government wherein the administration of affairs is lodged in the hands of a few persons. See GOVERNMENT

OLIVE. See OLEA.

OLIVINE, in mineralogy, a species of the Chrysolite family, found in the form of crystals, chiefly in basalt; colour between asparagus and olive-green; specific gravity 3.2. It is infusible before the blow-pipe; but with borax it melts into a dark-green bead. Nitric acid dissolves its iron, and deprives it of colour. It is found very abundantly in many parts of Germany; also in France, Norway, and Sweden, and in our country: according to Klaproth, it contains

Silica	48
Magnesia	37
Lime	0.25
Oxide of iron	12.5
	97.75
Loss	2.25
	100

OLYRA, in botany, a genus of the Monoecia Triandria class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: male, calyx glume one-flowered, awned; corolla glume awnless. Female, calyx glume one-flowered, spreading, ovate; style bifid; seed cartilaginous. There are two species, *viz.* O. paniculata, and O. pauciflora, both natives of Jamaica.

OMENTUM, the *caul*, in anatomy, a membranaceous part, usually furnished with a large quantity of fat; being placed under the peritonæum, and immediately above the intestines. See ANATOMY.

OMNIUM, a term in familiar use among stock-brokers and speculators in the funds, to express the whole of the articles which the subscribers to a loan receive from government. Thus if the subscribers, according to their agreement with government are to have for every hundred pounds advanced a certain sum in 3 per cent. consols, a further sum in 4 per cents, and a proportion of the long annuities, the blank receipts which they receive for making the instalments on the several articles, are, when disposed of independent of each other, as the 3 per cent. consols only, called scrip, but when the receipts are sold together as originally received, they are usually called omnium. As the omnium of every loan is the subject of extensive speculations, it generally is liable to considerable variations with respect to its current price, sometimes selling at a high premium, at other times at a discount, according to the circumstances which take place between the agreement for the loan and the day fixed for paying the last instalment. Thus the omnium of the year 1799, was at first at 4 and 5 per cent. premium; on the 20th of August it had risen to 19½, and on the 3d September was at 22¼; it soon after fell considerably, and on the 14th October was at 4½, 2½, 3¼; but on the 18th November it had got up again to 12 per cent. premium. The omnium of the year 1801 rose on the signing of preliminaries of peace, to 18 per cent., and was soon after at 25 per cent. premium: the omnium of the following year was at one time at 12 per cent. discount.

OMPHALEA, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character; male, calyx four-leaved; corolla none; filaments columnar, with the anthers inserted into it: female, calyx five-leaved; corolla none; stigma trifid; capsule fleshy, three-celled; nuts solitary. There are four species, all natives of Jamaica.

ONCHIDIUM, in natural history, a genus of the Vermes Mollusca class and order. Body oblong, creeping, flat beneath, mouth placed before; two feelers, situate above the mouth; two arms at the side of the head; vent behind and placed beneath. There is but a single species, *viz.* O. typhæ, the onch, which is described in the Transactions of the Linnæan society. It inhabits Bengal, on the leaves of the typha elephantina about an inch long, and not quite so broad, but linear, and longer

when creeping. In appearance it very much resembles a limax, but differs principally in wanting the shield and lateral pore, and in being furnished with a vent behind. Body above convex; head small and placed beneath, which when the animal is in motion is perpetually changing its form and size, and drawn in when at rest; mouth placed lengthways and continually varying its shape from circular to linear; feelers retractile resembling those of the slug, and apparently tipt with eyes; arms dilatable, solid, compressed, and palmate when fully expanded.

ONION in botany, see ALLIUM. Considered chemically it may be observed that as it possesses most of the properties of GARLIC (which see) though not in so large proportions, a volatile oil, on which its activity depends, might be expected, but this has not been found. Water distilled from it yeilds no oil; if therefore there is any oil it must be in very small quantities and soluble in water. The active principle of the onion acts upon the tin of the alembic in which experiments have been made,

ONISCUS, in natural history, a genus of insects of the order Aptera. Jaw truncate denticulate; lip bifid; antennæ from two to four, setaceous; body oval consisting of about fourteen transverse segments; fourteen legs. These insects feed on animal and vegetable matter, and they cast their skin. There are nearly fifty species divided into sections. A. without feelers; four antennæ, sessile. B. feelers unequal, the hind-ones longer; antennæ filiform. The most common species is the O. asellus, or common wood-louse, found in great quantities under the bark of decayed trees, beneath stones in damp situations. It preys on minuter insects. O. armadillo, the medical wood-louse, is of a darker colour than the former, but found in similar situations. When suddenly disturbed or touched, it rolls itself up into a round form in the manner of the armadillos; frequently remaining in that state for a considerable length of time. This insect was formerly considered as a specific in many disorders, but is now rarely used. Among marine insects of this genus, is the O. entomon, measuring two inches in length. It is a native of the European seas, and is found among rocks; it is of a strong fabric, the divisions of the upper part being of an almost calcareous nature.

ONOCLEA, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Generic character: capsules under the recurved and contracted pinnules of the frond, resembling pericarps. There are two species, viz. O. sensibilis and O. polypodioides, the former is a native of Virginia, the latter was found by Koenig, in the fissures of the rocks near the top of the Table Mountain at the Cape of Good Hope.

ONONIS, in botany, *restharrow*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx, five-parted, with linear segments; banner striated; legume turgid, sessile; filaments connate without a fissure. There are thirty-eight species; these are herbaceous plants or under shrubs; leaves ternate, with the leaflets often serrulate; stipules fastened to the bottom of the petiole; flowers yellow or purple, one or many flowered.

ONOPORDUM, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx scales mucronate; receptacle honey combed. There are seven species.

ONOSMA in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla, bell-shaped, with the throat pervious; seeds four. There are three species.

ONYX. See CHALCEDONY.

OPACITY, in philosophy, a quality of bodies which renders them impervious to the rays of light. It has been supposed that opacity consists in this, that the pores of the body are not all straight. This doctrine, however, is deficient: for though to have a body transparent, its pores must be straight, or rather open every way; yet it is inconceivable how it should happen, that not only glass and diamonds, but even water, whose parts are so very moveable, should have all their pores open and pervious every way; while the finest paper, or the thinnest gold leaf, should exclude the light, for want of such pores.

So that another cause of opacity must be sought for. Now all bodies have vastly more pores or vacuities than are necessary for an infinite number of rays to pass freely through them in right lines, without striking on any of the parts themselves. For since water is nineteen times lighter or rarer than gold; and yet gold itself is so very rare that magnetic effluvia pass freely

through it, without any opposition, and quicksilver is readily received within its pores, and even water itself by compression, it must have more pores than solid parts; consequently water must have at least forty times as much vacuity as solidity. The cause, therefore, why some bodies are opaque, does not consist in the want of rectilinear pores, pervious every way, but either in the unequal density of the parts, or in the magnitude of the pores, and to their being either empty, or filled with a different matter; by means of which the rays of light, in their passage, are arrested by innumerable refractions and reflections, till at length falling on some solid part, they become quite extinct, and are utterly absorbed. Hence cork, paper, wood, &c. are opaque; while glass, diamonds, &c. are pellucid. For in the confines or joining of parts alike in density, such as those of glass, water, diamonds, &c. among themselves, no refraction or reflection takes place, because of the equal attraction every way so that such of the rays of light as enter the first surface, pass straight through the body, excepting such as are lost and absorbed, by striking on solid parts: but in the bordering of parts of unequal density, such as those of wood and paper, both with regard to themselves, and with regard to the air, or empty space in their larger pores, the attraction being unequal, the reflections and refractions will be very great; and thus the rays will not be able to pass through such bodies, being continually driven about, till they become extinct.

That this interruption or discontinuity of parts is the chief cause of opacity, Sir Isaac Newton argues, appears from hence, that all opaque bodies immediately begin to be transparent, when their pores become filled with a substance of nearly equal density with their parts. Thus, paper dipped in water or oil, some stones steeped in water, linen cloth dipped in oil or vinegar, &c. become more transparent than before.

OPAL, in mineralogy, a species of the Quartz family, found in many parts of Europe, especially in Hungary. When first dug out of the earth it is soft, but it hardens and diminishes in bulk by exposure to the air. The specific gravity varies from 1.9 to 2.5. There are four subspecies, viz. the precious, the common, the semi, and the wood opal. Some specimens have the property of emitting various coloured rays, with a particular effulgency when placed between the eye and the light. The opals that possess this property are distinguished by lapidaries by the epithet oriental or nobilis. It is esteemed the most beautiful of the gems by Eastern nations; but in Europe it is not quite so highly valued on account of its liability to split on a sudden change of temperature: it is principally used for necklaces, ear-rings, and finger-rings. The most beautiful opals known are in the Imperial cabinet of Vienna; one is five inches long and two and a half in diameter: another is of the size and nearly of the shape of a hen's egg. The noble opal consists of silica and water in the proportion of 9 to 1. Specimens of the common and semi-opal have been analysed and found to consist as follows:

	Common Opal.	Semi Opal.
Silica	98.75	43.50
Alumina	0.1	0.0
Oxide of iron	0.1	47.
Water	0.0	7.5
	98.95	98.00
Loss	1.05	2
	100	100

OPATRUM, in natural history, a genus of insects of the order Coleoptera. Antennæ moniliform, thicker towards the tip; head projecting from a cavity in the thorax; thorax a little flattened, margined; shells immarginate, longer than the abdomen. There are twenty-eight species, O. sabulosum, is brown, shells with three indented raised lines; thorax emarginate. Inhabits Europe and America, on sand.

OPERA, a dramatic composition set to music, and sung on the stage, accompanied with musical instruments, and enriched with magnificent dresses, machines, and other decorations.

OPERA-*glass*, in optics, so called from its use in theatres, &c. it is sometimes called a "diagonal perspective" from its construction. It consists of a tube about four inches long, in each side of which there is a hole exactly against the middle of a plane mirror which reflects the rays falling upon it, to the convex glass, through which they are refracted to the concave eye-glass, whence they emerge parallel to the eye at the hole in the tube. This instrument is not intended to magnify objects more than about two or three times. The peculiar artifice is to view a person at a small distance, so that no one shall know who is observed: for the instrument points to a different object from that which is view-

ed; and as there is a hole on each side, it is impossible to know on which hand the object is situated, which you are looking at.

OPERCULARIA, in botany, a genus of the Tetrandria Monogynia class and order. Essential character: flower compound; calyx common, one-leafed, unequally toothed, closed by a common receptacle, flowering above, seeding below, falling when ripe. There are three species.

OPHIDIUM, in natural history, a genus of fishes of the order Apodes. Generic character: the head rather naked; teeth in the jaws, palate, and throat; gill membrane seven-rayed; body in the form of a sword. There are four species. We shall notice only O. barbatum, or the bearded Ophidium: this is generally about eight inches long, and is a native of the Adriatic and Mediterranean Seas. On the coasts of Provence it is often taken with other fishes in nets, but by no means highly valued. It subsists on small fishes and crabs.

OPHIOGLOSSUM, in botany, *adder's tongue*, a genus of the Cryptogamia Filices class and order. Natural order of Filices, or Ferns. Generic character: capsules numerous, connected by a membrane into a distich spike, subglobular, when ripe opening transversely, without any elastic ring; seeds very many, extremely minute. There are nine species.

OPHIORHIZA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Gentianæ, Jussieu. Essential character: corolla funnel-form; germ bifid; stigmas two; fruit two-lobed. There are three species.

OPHIOXYLUM, in botany, *serpentine wood*, a genus of the Polygamia Monoecia class and order. Natural order of Apocineæ, Jussieu. Essential character: hermaphrodite, calyx five-cleft; corolla five-cleft, funnel-form; stamens five; pistil one: male, calyx bifid; corolla five-cleft, with a funnel-form mouth; nectary cylindric; stamens two. There is but one species; *viz.* O. serpentinum, scarlet-flowered ophioxylum, a native of the East Indies.

OPHIRA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Onagræ, Jussieu. Essential character: involucre two-valved, three-flowered; corolla four-petalled, superior; berry one-celled. There is but one species, *viz.* O. stricta, a native of Africa.

OPHRYS, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary somewhat keeled underneath. There are thirty-four species. These plants are of the same natural genus with the Orchis. Linnæus distinguished this natural order into genera from the nectarium, which in Orchis forms a horn or spur at the back of the flower, whereas the lip of it in this is a petal, hanging down with a ridge or keel running along the back. O. nidus avis, bird's nest Ophrys, has the root composed of many strong fibres, from which arise two oval veined leaves, jointed at their base; between these spring up a naked stalk, about eight inches in height, terminated by a loose spike of herbaceous flowers, resembling gnats, composed of five petals, with a long bifid lip to the nectarium, a crest or standard above, and two wings on the side; capsule angular, opening in six parts, filled with small seeds like dust. Native of several parts of Europe.

OPHTHALMIA, in medicine, an inflammation of the membranes which invest the eye.

OPIUM, in chemistry and medicine, an inspissated gummy juice, which is obtained from the head of the "papaper somniferum." It is imported from Persia, Arabia, and other warm parts of Asia, in flat cakes covered with leaves to prevent their sticking together. It has a reddish brown colour, and strong peculiar smell: its taste at first is nauseous and bitter; but this soon becomes acrid, and produces a slight warmth in the mouth. A peculiar substance has been detected in opium, to which it is supposed the properties it possesses of producing sleep are owing. On account of this property this substance has received the name of narcotic matter. It is obtained from the milky juices of some plants, as those of the poppy, lettuce, and some others. Opium, which is extracted from the poppy, is prepared by the following process. The heads of the white poppy, which is cultivated in different countries of the east for this purpose, are wounded with a sharp instrument; a milky juice flows out, which concretes, and is collected and formed into cakes. In this state opium is a tenacious substance, of a brownish colour; has a peculiar smell, and a disagreeable bitter taste. It becomes soft with a moderate heat. It readily takes fire, and burns rapidly. By the analysis of opium, it appears to

be composed of the sulphates of lime and of potash, extractive matter, gluten, mucilage, resinous matter, and an oil, besides the narcotic matter, to which its peculiar properties are owing. By digesting opium in water, part of it is dissolved, and by evaporating the solution to the consistence of syrup, a gritty precipitate appears, which becomes more copious with the addition of water. This precipitate is composed of resinous and extractive matter, besides the peculiar narcotic matter which is crystallized. When alcohol is digested on this precipitate, the resinous and narcotic matters are dissolved, and the extractive matter remains behind. As the solution cools, the narcotic matter crystallizes; but the crystals are coloured with a portion of resin. By repeated solutions and crystallizations it may be obtained tolerably pure. If alcohol be digested on the residuum, it becomes of a deep red colour, the same crystals are deposited on cooling, and may be purified in the same way from the resinous matter with which they are contaminated. The narcotic matter, when properly purified, is of a white colour; crystallizes in right-angled prisms, with a rhomboidal base; and has neither taste nor smell. It is insoluble in cold water, and requires 400 parts of boiling water for its solution, from which it is precipitated by cooling. The solution does not redden the tincture of turnsole. It is soluble in 24 parts of boiling alcohol, and requires about 100 parts when it is cold. When water is added to the solution in alcohol, it is precipitated in the form of a white opaque matter. One of the most decided characters of this substance is its easy solubility in all the acids, and without the aid of heat. It is precipitated from these solutions by means of an alkali, in the form of white powder. Pure alkalies increase the power of its solubility in water, and the acids, when not added in excess, occasion a precipitate. When nitric acid is poured on the crystals reduced to a coarse powder, it communicates to them a red colour, and readily dissolves them. When the solution is heated and evaporated, it yields crystals of oxalic acid in considerable quantity. The residuum has a very bitter taste. From the effects of heat and of nitric acid on this substance it appears to be composed of oxygen, hydrogen, carbon, and azote. This narcotic substance is also found in the milky juice, and in the extracts which are obtained from several other plants, as from different species of lactuca, or lettuce; hyoscyamus niger, or henbane. The leaves of some plants also produce similar effects, as those of the deadly nightshade, fox-glove, and conium maculatum, or hemlock. See Poppy.

OPOPANAX. See Gum *resin*.

OPOSSUM. See Didelphis.

OPTICS, the science of vision, including Catoptrics and Dioptrics, and even Perspective; as also the whole doctrine of light and colours, and all the phenomena of visible objects. See Perspective.

Optics, in its more extensive acceptation, is a mixed mathematical science, which explains the manner in which vision is performed in the eye; treats of sight in general; gives the reasons of the several modifications or alterations, which the rays of light undergo in the eye; and shows why objects appear sometimes greater, sometimes smaller, sometimes more distinct, sometimes more confused, sometimes nearer, and sometimes more remote. In this extensive signification it is considered by Sir Isaac Newton, in his Optics. Indeed optics make a considerable branch of natural philosophy; both as it explains the laws of nature, according to which vision is performed, and as it accounts for abundance of physical phenomena, otherwise inexplicable.

The reflection of the rays of light is, indeed, an occurrence too frequent and obvious to have escaped the notice even of the earliest observers; a river or some other piece of water was probably the first mirror; its effect was afterward imitated by metallic mirrors: hence was discovered the equality of the angles of incidence and reflection. It was known at an early period that an oar, or other straight piece of wood, partially immersed in water, no longer appeared straight, yet ages after this elapsed before any attempts were made to ascertain the relation between the angles of incidence and refraction. Empedocles was the first person on record that wrote systematically on light; and Euclid composed a treatise on the ancient optics and catoptrics; dioptrics being less known to the ancients, though it was not quite unnoticed by them, for among the phenomena at the beginning of that work, Euclid remarks the effect of bringing an object into view, by refraction, in the bottom of a vessel, by pouring water into it, which could not be seen over the edge of the vessel before the water was poured in; and other authors speak of the then known effects of glass globes, &c. both as burning glasses, and as to bodies

seen through them. Euclid's work, the genuineness of which has been doubted, is chiefly on catoptrics, or reflected rays; in which he shows the chief properties of them in plane, convex, and concave surfaces, in his usual geometrical manner, beginning with that concerning the equality of the angles of incidence and reflection, which he demonstrates; and in the last proposition, showing the effect of a concave speculum, as a burning glass, when exposed to the rays of the sun.

The effects of burning glasses, both by refraction and reflection, are noticed by several others of the ancients, and it has been thought that the Romans had a method of lighting their sacred fire by some such means. Aristophanes, in one of his comedies, introduces a person as making use of a globe filled with water to cancel a bond that was against him, by thus melting the wax of the seal. If we give credit to what some ancient historians are said to have written concerning the exploits of Archimedes, we shall be induced to think that he constructed some very powerful burning mirrors. It is even allowed that this eminent geometrician wrote a treatise on the subject of them, though it be not now extant; as also concerning the appearance of a ring or circle under water, and therefore could not have been ignorant of the common phenomena of refraction. We find many questions concerning optical appearances in the works of Aristotle. This author was also sensible that it is the reflection of light from the atmosphere which prevents total darkness after the sun sets, and in places where he does not shine in the day time. He was also of opinion, that rainbows, halos, and mock suns were all occasioned by the reflection of the sunbeams in different circumstances, by which an imperfect image of his body was produced, the colour only being exhibited, and not his proper figure. The ancients were not only acquainted with the more ordinary appearances of refraction, but knew also the production of colours by refracted light. Seneca says, that when the light of the sun shines through an angular piece of glass, it shows all the colours of the rainbow. These colours, however, he says, are false, such as are seen in a pigeon's neck when it changes its position; and of the same nature he says is a speculum, which, without having any colour of its own, assumes that of any other body.

It appears also, that the ancients were not unacquainted with the magnifying power of glass globes filled with water, though they probably knew nothing of the reason of this power; and it is supposed that the ancient engravers made use of a glass globe filled with water to magnify their figures, that they might work to more advantage.

Ptolemy, about the middle of the second century, wrote a considerable treatise on optics. The work is lost; but from the accounts of others it appears that he there treated of astronomical refractions. The first astronomers were not aware that the intervals between stars appear less when near the horizon than in the meridian; and on this account they must have been much embarrassed in their observations; but it is evident that Ptolemy was aware of this circumstance by the caution which he gives to allow something for it, whenever recourse is had to ancient observations. This philosopher also advances a very remote hypothesis to account for the remarkably great apparent size of the sun and moon when seen near the horizon. The mind, he says, judges of the size of objects by means of a preconceived idea of their distance from us; and this distance is fancied to be greater when a number of objects are interposed between the eye and the body we are viewing, which is the case when we see the heavenly bodies near the horizon. In his Almagest, however, he ascribes this appearance to a refraction of the rays by vapours, which actually enlarge the angle under which the luminaries appear, just as the angle is enlarged by which an object is seen from under water. See Ptolemy.

Alhazen, an Arabian writer, was the next author of consequence, who wrote about the year 1100. Alhazen made many experiments on refraction, at the surface between air and water, air and glass, and water and glass; and hence he deduced several properties of atmospherical refraction, such as, that it increases the altitudes of all objects in the heavens; and he first advanced that the stars are sometimes seen above the horizon by means of refraction, when they are really below it; which observation was confirmed by Vitellio, Walther, and especially by the observations of Tycho Brahe. Alhazen observed, that refraction contracts the diameters and distances of the heavenly bodies, and that it is the cause of the twinkling of the stars. This refractive power he ascribed, not to the vapours contained in the air, but to its different degrees of transparency. And it was his opinion, that so

far from being the cause of the heavenly bodies appearing larger near the horizon, that it would make them appear less; observing that two stars appear nearer together in the horizon, than near the meridian. This phenomenon he ranks among optical deceptions. We judge of distance, he says, by comparing the angle under which objects appear, with their supposed distance; so that if these angles be nearly equal, and the distance of one object be conceived greater than that of the other, this will be imagined to be the larger. And he further observes, that the sky near the horizon is always imagined to be further from us than any other part of the concave surface.

In the writings of Alhazen, too, we find the first distinct account of the magnifying power of glasses, and it is not improbable that his writings on this head gave rise to the useful invention of spectacles; for he says, that if an object be applied close to the base of the larger segment of a sphere of glass, it will appear magnified. He also treats of the appearance of an object through a globe, and says that he was the first who observed the refraction of rays into it.

In 1270, Vitellio, a native of Poland, published a treatise on optics, containing all that was valuable in Alhazen, and digested in a better manner. He observes, that light is always lost by refraction, which makes objects appear less luminous. He gave a table of the results of his experiments on the refractive powers of air, water, and glass, corresponding to different angles of incidence. He ascribes the twinkling of the stars to the motion of the air in which the light is refracted; and he illustrates this hypothesis by observing, that they twinkle still more when viewed in water put in motion. He also shows, that refraction is necessary as well as reflection, to form the rainbow; because the body which the rays fall upon is a transparent substance, at the surface of which one part of the light is always reflected, and another refracted. And he makes some ingenious attempts to explain refraction, or to ascertain the law of it. He also considers the foci of glass spheres, and the apparent size of objects seen through them, though with but little accuracy. See REFRACTION.

Contemporary with Vitellio was Roger Bacon, a man of very extensive genius, who wrote upon almost every branch of science; though it is thought his improvements in optics were not carried far beyond those of Alhazen and Vitellio: to him, however, has been attributed the invention of the MAGIC LANTERN, which see.

One of the next who distinguished himself in this way was Maurolycus, teacher of mathematics at Messina. In a treatise, "De Lumine et Umbra," published in 1575, he demonstrates, that the crystalline humour of the eye is a lens that collects the rays of light issuing from the objects, and throws them upon the retina, where the focus of each pencil is. From this principle he discovered the reason why some people are short-sighted, and others long-sighted; also why the former are relieved by concave glasses, and the others by convex ones.

Contemporary with Maurolycus was John Baptista Porta, of Naples. He discovered the camera obscura, which throws considerable light on the nature of vision. His house was the constant resort of all the ingenious persons at Naples, whom he formed into what he called An Academy of Secrets, each member being obliged to contribute something that was not generally known, and might be useful. By this means he was furnished with materials for his "Magia Naturalis," which contains his account of the camera obscura, and the first edition of which was published, as he informs us, when he was not quite fifteen years old. He also gave the first hint of the magic lantern, which Kircher afterwards followed and improved. His experiments with the camera obscura convinced him, that vision is performed by the intromission of something into the eye, and not by visual rays proceeding from it, as had been formerly imagined; and he was the first who fully satisfied himself and others upon this subject. He justly considered the eye as a camera obscura, and the pupil the hole in the window-shutter; but he was mistaken in supposing that the crystalline humour corresponds to the wall which receives the images; nor was it discovered till the year 1604, that this office is performed by the retina. He made a variety of just remarks concerning vision, and particularly explained several cases in which we imagine things to be without the eye, when the appearances are occasioned by some affection of the eye itself, or by some motion within the eye. He remarked also, that, in certain circumstances, vision will be assisted by convex or concave glasses; and he seems even to have made some small advances to-

wards the discovery of telescopes. Other treatises on optics, with various and gradual improvements, were afterwards successively published by several authors, whose names, with the titles and brief accounts of their several works would occupy a large space. We must, however, mention the excellent work on optics, by Dr. Smith, 2 vols. 4to.; an abridgment of which was made by Dr. Kipling, for the use of the students at the universities, entitled "Elementary Parts of Dr. Smith's Optics," &c. 1778; and an elaborate History of the Present State of Discoveries relating to Vision, Light, and Colours, by Dr. Priestley, 4to. 1772; a work highly instructive and entertaining to persons who have a taste for physics.

The laws of optics depending upon the properties of LIGHT, the reader will do well, as introductory to this article, to refer to what has been said in our fourth volume on that subject. There will be found much curious speculation, and a variety of interesting facts relating to the nature of light, its velocity, and the direction which it takes in moving through free space and through our atmosphere. We shall in this place give a few definitions necessary to the mere student.

By a ray of light, is meant the motion of a single particle; and its motion is represented by a straight line. Any parcel of rays proceeding from a point, is called a pencil of rays. By a medium, is meant any pellucid or transparent body, which suffers light to pass through it. Thus, water, air, and glass, are called media. Parallel rays, are such as move always at the same distance from each other. If rays continually recede from each other, as from C to *c d* (Plate I. Optics, fig. 1.) they are said to diverge. If they continually approach towards each other, as in moving from *c d* to C, they are said to converge. The point at which converging rays meet, is called the focus. The point towards which they tend, but which they are prevented from coming to, by some obstacle, is called the imaginary focus. When rays, after passing through one medium, on entering another medium of different density, are bent out of their former course, and made to change their direction, they are said to be refracted: thus A C (fig. 2), is a ray which, when it enters the medium H G K instead of proceeding in the same direction C L, it is made to move in the direction C S. When they strike against a surface, and are sent back again from the surface, they are said to be reflected. The *incident* ray, as A C, is that which comes from any luminous body, and falls upon the reflecting surface, as H K, and C M is the reflected ray. The angle of incidence, is that which is contained between the incident ray A C and a perpendicular to the reflecting surface in the point of reflection, as the angle A C D. The angle of reflection, is that contained between the said perpendicular D C, and the reflected ray C M, *viz.* the angle D C M. The angle of refraction, is that contained between the refracted ray C S, and the perpendicular C N, *viz.* the angle F C K. The angle of deviation, is that which is contained between the line of direction of an incident ray A L, and the direction of the same ray C F after it is refracted; thus the angle L C F is the angle of deviation.

A lens, is glass ground into such a form as to collect or disperse the rays of light which pass through it. These are of different shapes, and from thence receive different names. A plano-convex, has one side flat, and the other convex, as A (fig. 3.) A plano concave is flat on one side, and concave on the other, as B. A double convex, is convex on both sides, as C. A double concave, is concave on both sides, as D. A meniscus, is convex on one side and concave on the other, as E. A line passing through the centre of a lens, as F G, is called its axis.

Of Refraction. If the rays of light, after passing through a medium, enter another of a different density perpendicular to its surface, they proceed through this medium in the same direction as before. Thus the ray O P (fig. 2.) proceeds to K, in the same direction. But if they enter obliquely to the surface of a medium, either denser or rarer than what they moved in before, they are made to change their direction in passing through that medium. If the medium which they enter be denser, they move through it in a direction nearer to the perpendicular drawn to its surface. Thus, A C, upon entering the denser medium H G K instead of proceeding in the same direction A L is bent into the direction C F, which makes a less angle with the perpendicular O P. On the contrary, when light passes out of a denser into a rarer medium, it moves in a direction farther from the perpendicular. Thus, if S C were a ray of light which had passed through the dense medium H G K, on arriving at the rarer medium it would move in the direction C A, which makes a greater angle with the

perpendicular. This refraction is greater or less, that is, the rays are more or less bent or turned aside from their course, as the second medium through which they pass is more or less dense than the first. Thus, for instance, light is more refracted in passing from air into glass, than from air into water; glass being denser than water. And, in general, in any two given media, the sine of any one angle of incidence has the same ratio to the sine of the corresponding angle of refraction, as the sine of any other angle of incidence has to the sine of its corresponding angle of refraction. Hence, when the angle of incidence is increased, the corresponding angle of refraction is also increased; because the ratio of their sines cannot continue the same, unless they be both increased; and if two angles of incidence be equal, the angles of refraction will be equal. The angle of deviation must also vary with the angle of incidence. If a ray of light, A C, (fig. 2) pass obliquely out of air into glass, A D the sine of the angle of incidence A C D, is to N S, the sine of the angle of refraction N C S, nearly as 3 to 2; therefore, supposing the sines proportional to the angles, the sine of F C L the angle of deviation, is as the difference between A D and N S, that is, as 3—2, or 1, whence the sine of incidence is to the sine of the angle of deviation as 3 to 1. In like manner it may be shewn, that when the ray passes obliquely out of glass into air, the sine of the angle of incidence will be to that of deviation, as N S to A D—N S, that is, as 2 to 1. In passing out of air into water, the sine of the angle of incidence is to that of refraction, as 4 to 3, and to that of deviation, as 4 to 4—3, or 1; and in passing out of water into air, the sine of the angle of incidence is to that of refraction, as 3 to 4, and to that of deviation, as 3 to 1. Hence a ray of light cannot pass out of water into air at a greater angle of incidence than 48° 36′, the sine of which is to radius as 3 to 4. Out of glass into air the angle must not exceed 40° 11′, because the sine of 40° 11′ is to radius as 2 to 3 nearly; consequently, when the sine has a greater proportion to the radius than that mentioned, the ray will not be refracted. It must be observed, that when the angle is within the limit, for light to be refracted, some of the rays will be reflected. For the surfaces of all bodies are for the most part uneven, which occasions the dissipation of much light by the most transparent bodies; some being reflected, and some refracted, by the inequalities on the surfaces. Hence a person can see through water, and his image reflected by it at the same time. Hence also, in the dusk, the furniture in a room may be seen by the reflection of a window, while objects that are without are seen through it.

Upon a smooth board, about the centre C, describe a circle H O K P; draw two diameters of the circle, O P, H K, perpendicular to each other; draw A D M perpendicular to O P; cut off D T and C I equal to three-fourths D A; through T I, draw T I S, cutting the circumference in S; N S drawn from S perpendicularly upon O P, will be equal to D T, or three-fourths of D A. Then if pins be stuck perpendicularly at A, C, and S, and the board be dipped in the water as far as the line H K, the pin at S will appear in the same line with the pins at A and C. This shews, that the ray which comes from the pin S is so refracted at C, as to come to the eye along the line C A; whence the sine of incidence A D is to the sine of refraction N S, as 4 to 3. If other pins were fixed along C S, they would all appear in A C produced; which shews that the ray is bent at the surface only. The same may be shewn, at different inclinations of the incident ray, by means of a moveable rod turning upon the centre C, which always keep the ratio of the sines A D, N S, as 4 to 3. Also the sun's shadow, coinciding with A C, may be shewn to be refracted in the same manner. The image L, of a small object S, placed under water, is one-fourth nearer the surface than the object. And hence the bottom of a pond, river, &c. is one-third deeper than it appears to a spectator.

To prove the refraction of light in a different way, take an upright empty vessel into a dark room; make a small hole in the window-shutter, so that a beam of light may fall upon the bottom at *a* (fig. 4) where you may make a mark. Then fill the bason with water, without moving it out of its place, and you will see that the ray, instead of falling upon *a*, will fall at *b*. If a piece of looking-glass be laid in the bottom of the vessel, the light will be reflected from it, and will be observed to suffer the same refraction as in coming in; only in a contrary direction. If the water be made a little muddy, by putting into it a few drops of milk, and if the room be filled with dust, the rays will be rendered much more visible. The same may be proved by another experiment. Put a piece of money into

the bason when empty, and walk back till you have just lost sight of the money, which will be hidden by the edge of the bason. Then pour water into the bason, and you will see the money distinctly, though you look at it exactly from the same spot as before. See (fig. 2) where the piece of money at S will appear at L. Hence also the straight oar, when partly immersed in water, will appear bent, as A C S.

If the rays of light fall upon a piece of flat glass, they are refracted into a direction nearer to the perpendicular, as described above, while they pass through the glass; but after coming again into air, they are refracted as much in the contrary direction; so that they move exactly parallel to what they did before entering the glass. But, on account of the thinness of the glass, this deviation is generally overlooked, and it is considered as passing directly through the glass.

If parallel rays, *a b* (fig. 1) fall upon a plano-convex lens, *c d*, they will be so refracted, as to unite in a point, *e*, behind it; and this point is called the "principal focus," or the "focus of parallel rays;" the distance of which from the middle of the glass, is called the "focal distance," which is equal to twice the radius of the sphere, of which the lens is a portion.

When parallel rays, as A B (fig. 5) fall upon a double convex lens, they will be refracted, so as to meet in a focus, whose distance is equal to the radius or semidiameter of the sphere of the lens.

Ex. 1. Let the rays of the sun pass through a convex lens into a dark room, and fall upon a sheet of white paper placed at the distance of the principal focus from the lens. 2. The rays of a candle in a room from which all external light is excluded, passing through a convex lens, will form an image on white paper.

But if a lens be more convex on one side than on the other, the rule for finding the focal distance is this: as the sum of the semi-diameters of both convexities is to the semi-diameter of either, so is double the semi-diameter of the other to the distance of the focus; or divide the double product of the radii by their sums, and the quotient will be the distance sought.

Since all the rays of the sun which pass through a convex glass are collected together in its focus, the force of all their heat is collected into that part; and is in proportion to the common heat of the sun, as the area of the glass is to the area of the focus. Hence we see the reason why a convex glass causes the sun's rays to burn after passing through it. See Burning *glass*.

All those rays cross the middle ray in the focus *f*, and then diverge from it to the contrary sides, in the same manner as they converged in coming to it. If another glass, F G, of the same convexity as D E, be placed in the rays at the same distance from the focus, it will refract them so, as that, after going out of it, they will be all parallel, as *b c*; and go on in the same manner as they came to the first glass D E, but on the contrary sides of the middle ray. The rays diverge from any radiant point, as from a principal focus; therefore, if a candle be placed at *f*, in the focus of the convex glass F G, the diverging rays in the space F *f* G, will be so refracted by the glass, that, after going out of it, they will become parallel, as shewn in the space *c b*. If the candle be placed nearer the glass than its focal distance, the rays will diverge, after passing through the glass, more or less, as the candle is more or less distant from the focus.

If the candle be placed further from the glass than its focal distance, the rays will converge, after passing through the glass, and meet in a point, which will be more or less distant from the glass, as the candle is nearer to, or further from, its focus; and where the rays meet, they will form an inverted image of the flame of the candle; which may be seen on a paper placed in the meeting of the rays.

Hence, if any object, A B C (fig. 6), be placed beyond the focus, F, of the convex glass, *d e f*, some of the rays which flow from every point of the object, on the side next the glass, will fall upon it, and after passing through it, they will be converged into as many points on the opposite side of the glass, where the image of every point will be formed, and consequently the image of the whole object, which will be inverted. Thus the rays, A *d*, A *e*, A *f*, flowing from the point A, will converge in the space, *d a f*, and by meeting at *a*, will there form the image of the point A. The rays, B *d*, B *e*, B *f*, flowing from the point, B, will be united at *b*, by the refraction of the glass, and will there form the image of the point, B. And the rays, C *d*, C *e*, C *f*, flowing from the point, C, will be united at *c*, where they will form the image of the point, C. And so of all the intermediate points between A and C.

If the object, A B C, be brought nearer

to the glass, the picture, *a b c*, will be removed to a greater distance; for then, more rays flowing from every single point, will fall more diverging upon the glass; and therefore cannot be so soon collected into the corresponding points behind it. Consequently, if the distance of the object, A B C (fig. 7), be equal to the distance, *e* B, of the focus of the glass, the rays of each pencil will be so refracted by passing through the glass, that they will go out of it parallel to each other; as *d* I, *e* H, *f* h, from the point C; *d* G, *e* K, *f* D, from the point B; and *d* K, *e* E, *f* L, from the point A; and therefore there will be no picture formed behind the glass.

If the focal distance of the glass, and the distance of the object from the glass, be known, the distance of the picture from the glass may be found by this rule, viz. multiply the distance of the focus by the distance of the object, and divide the product by their difference; the quotient will be the distance of the picture.

The picture will be as much bigger, or less, than the object, as its distance from the glass is greater or less than the distance of the object: for (fig. 6) as B *e* is to *e b*, so is A C to *c a*; so that if A B C be the object, *c b a* will be the picture; or if *c b a* be the object, A B C will be the picture.

If rays converge before they enter a convex lens, they are collected at a point nearer to the lens than the focus of parallel rays. If they diverge before they enter the lens, they are then collected in a point beyond the focus of parallel rays; unless they proceed from a point on the other side at the same distance with the focus of parallel rays; in which case they are rendered parallel.

If they proceed from a point nearer than that, they diverge afterwards, but in a less degree than before they entered the lens.

When parallel rays, as *a b c d e* (fig. 8), pass through a concave lens, as A B, they will diverge after passing through the glass, as if they had come from a radiant point, C, in the centre of the convexity of the glass; which point is called the "virtual, or imaginary focus."

Thus, the ray, *a*, after passing through the glass, A B, will go on in the direction, *k l*, as if it had proceeded from the point, C, and no glass been in the way. The ray, *b*, will go on in the direction, *m n*; the ray, *c*, in the direction, *o p*, &c. The ray, C, that falls directly upon the middle of the glass, suffers no refraction in passing through it, but goes on in the same rectilinear direction, as if no glass had been in the way.

If the glass had been concave only on one side, and the other side quite flat, the rays would have diverged, after passing through it, as if they had come from a radiant point at double the distance of C from the glass; that is, as if the radiant had been at the distance of a whole diameter of the glass's convexity.

If rays come more converging to such a glass, than parallel rays diverge after passing through it, they will continue to converge after passing through it; but will not meet so soon as if no glass had been in the way; and will incline towards the same side to which they would have diverged, if they had come parallel to the glass.

Of Reflection. When a ray of light falls upon any body, it is reflected, so that the angle of incidence is equal to the angle of reflection; and this is the fundamental fact upon which all the properties of mirrors depend. This has been attempted to be proved upon the principle of the composition and resolution of forces or motion: let the motion of the incident ray be expressed by A C (fig. 2); then A D will express the parallel motion, and A B the perpendicular motion. The perpendicular motion after reflection will be equal to that before reflection, and therefore may be expressed by D C = A D. The parallel motion, not being affected by reflection, continues uniform, and will be expressed by D M = A D; therefore the course of the ray will be C M, and by a well-known proposition in Euclid A C D = D C M. The fact may, however, be proved by experiment in various ways; the following method will be readily understood.

Having described a semicircle on a smooth board, and from the circumference let fall a perpendicular bisecting the diameter, on each side of the perpendicular cut off equal parts of the circumference; draw lines from the points in which those equal parts are cut off to the centre; place three pins perpendicular to the board, one at each point of section in the circumference, and one at the centre; and place the board perpendicular to a plane mirror. Then look along one of the pins in the circumference to that in the centre, and the other pin in the circumference will appear

in the same line produced with the first, which shews that the ray which comes from the second pin, is reflected from the mirror at the centre of the eye, in the same angle in which it fell on the mirror. 2. Let a ray of light, passing through a small hole into a dark room, be reflected from a plane mirror, at equal distances from the point of reflection, the incident, and the reflected ray, will be at the same height from the surface.

Again, if from a centre, C, with the radius, C A, the circle, A M P, be described, the arc, A O, will be found equal to the arc, O M, therefore the angle of incidence is equal to the angle of reflection. The same is found to hold in all cases when the rays are reflected at a curved surface, whether it be convex or concave.

With regard to plane specula, it is found that the image and the object formed by it are equally distant from the speculum, at opposite sides: they are also equal, and similarly situated.

When parallel rays, as *d f a*, C *m b*, *e l c*, (fig. 9) fall upon a concave mirror, A B, they will be reflected back from that mirror, and meet in a point, *m*, at half the distance of the surface of the mirror from, C, the centre of its concavity; for they will be reflected at as great an angle from the perpendicular, to the surface of the mirror, as they fell upon it, with regard to that perpendicular, but on the other side thereof. Thus, let C be the centre of concavity of the mirror, A *b* B, and let the parallel rays, *d f a*, C *m b*, and *e l c*, fall upon it at the points, *a*, *b* and *c*. Draw the lines, C i *a*, C *m b*, and C *h c*, from the centre, C, to these points; and all these lines will be perpendicular to the surface of the mirror, because they proceed thereto like so many radii from its centre. Make the angle, C *a h*, equal to the angle *d a* C, and draw the line, *a m h*, which will be the direction of the ray, *d f a*, after it is reflected from the point of the mirror: so that the angle of incidence, *d a* C, is equal to the angle of reflection, C *a h*; the rays making equal angles with the perpendicular, C i *a*, on its opposite sides. Draw also the perpendicular, C *h c*, to the point, *c*, where the ray, *e l c*, touches the mirror; and, having made the angle, C *c i*, equal to the angle, C *c e*, draw the line, *c m i*, which will be the course of the ray, *e l c*, after it is reflected from the mirror. The ray, C *m b*, passes through the centre of concavity of the mirror, and falls upon it at *b*, perpendicular to it; and is therefore reflected back from it in the same line, *b m* C. All these reflected rays meet in the point, *m*; and in that point the image of the body which emits the parallel rays, *d a*, C *b*, and *e c*, will be formed; which point is distant from the mirror equal to half the radius, *b m* C, of its concavity.

The rays which proceed from any celestial object, may be esteemed parallel at the earth; and, therefore, the images of that object will be formed at *m*, when the reflecting surface of the concave mirror is turned directly towards the object. Hence the focus of the parallel rays is not in the centre of the mirror's concavity, but half way between the mirror and that centre. The rays which proceed from any remote terrestrial object, are nearly parallel at the mirror; not strictly so, but come diverging to it in separate pencils, or, as it were, bundles of rays, from each point of the side of the object next the mirror; therefore they will not be converged to a point at the distance of half the radius of the mirror's concavity from its reflecting surface, but in separate points at a little greater distance from the mirror. And the nearer the object is to the mirror, the further these points will be from it; and an inverted image of the object will be formed in them, which will seem to hang pendent in the air; and will be seen by an eye placed beyond it (with regard to the mirror), in all respects like the object, and as distinct as the object itself.

Let A *c* B (fig. 10), be the reflecting surface of a mirror, whose centre of concavity is at C; and let the upright object, D E, be placed beyond the centre, C, and send out a conical pencil of diverging rays from its upper extremity, D, to every point of the concave surface of the mirror, A *c* B. But to avoid confusion, we only draw three rays of that pencil; as D A, D *c*, D B. From the centre of concavity, C, draw the three right lines, C A, C *c*, C B, touching the mirror in the same points where the aforesaid touch it, and all these lines will be perpendicular to the surface of the mirror. Make the angle, C A *d* equal to the angle, D A C, and draw the right line, A *d*, for the course of the reflected ray, D A: make the angle, C *c d*, equal to the angle, D *c* C, and draw the right line, *c d*, for the course of the reflected ray, D *c*; make also the angle, C B *d*, equal to the angle, D B C, and draw the right light line, B *d*,

for the course of the reflected ray, D B. All these reflected rays will meet in point *d*, where they will form the extremity, *d*, of the inverted image, *e d*, similar to the extremity, D, of the upright object, D E. If the pencil of rays, E *f*, E *g*, E *h*, be also continued to the mirror, and their angles of reflection from it be made equal to their angles of incidence upon it, as in the former pencil from D, they will meet at the point, *e*, by reflection, and form the extremity, *e*, of the image, *e d*, similar to the extremity, E, of the object, D E. As each intermediate point of the object between D and E, sends out a pencil of rays in like manner to every part of the mirror, the rays of each pencil will be reflected back from it, and meet in all the intermediate points between the extremities, *e* and *d*, of the image; and so the whole image will be formed not at *i*, half the distance of the mirror from its centre of concavity, C; but at a greater distance between *i* and the object, D E; and the image will be inverted with respect to the object. This being well understood, the reader will easily see how the image is formed by the large concave mirror of the reflecting telescope, when he comes to the description of that instrument. See TELESCOPE.

When the object is more remote from the mirror than its centre of concavity, C, the image will be less than the object, and between the object and the mirror; when the object is nearer than the centre of concavity, the image will be more remote, and bigger than the object: thus, if D E be the object, *e d* will be its image; for as the object recedes from the mirror, the image approaches nearer to it; and as the object approaches nearer to the mirror, the image recedes further from it; on account of the lesser or greater divergency of the pencils of rays which proceed from the object; for the less they diverge, the sooner they are converged to points by reflection; and the more they diverge, the further they must be reflected before they meet. If the radius of the mirror's concavity and the distance of the object of it be known, the distance of the image from the mirror is found by this rule: Divide the product of the distance and radius by double the distance made less by the radius, and the quotient is the distance required. If the object be in the centre of the mirror's concavity, the image and object will be coincident, and equal in bulk.

If a man place himself directly before a large concave mirror, but further from it than its centre of concavity, he will see an inverted image of himself in the air, between him and the mirror, of a less size than himself. And if he hold out his hand towards the mirror, the hand of the image will come out towards his hand, and coincide with it, of an equal bulk, when his hand is in the centre of concavity; and he will imagine he may shake hands with his image. If he reach his hand further, the hand of the image will pass by his hand, and come between it and his body; and if he move his hand towards either side, the hand of the image will move towards the other; so that whatever way the object moves, the image will move the contrary way. A by-stander will see nothing of the image, because none of the reflected rays that form it enter his eyes.

The images formed by convex specula are in positions similar to those of their objects; and those also formed by concave specula, when the object is between the surface and the principal focus: in these cases the image is only imaginary, as the reflected rays never come to the foci from whence they seem to diverge. In all other cases of reflection from concave specula, the images are in positions contrary to those of their objects, and these images are real, for the ray after reflection do come to their respective foci. These things are evident from what has gone before. See MIRROR.

"Of colours and the different refrangibility of light." The origin of colours is owing to the composition which takes place in the rays of light, each heterogeneous ray consisting of innumerable rays of different colours; this is evident from the separation that ensues in the well-known experiment of the prism. A ray being let into a darkened room (fig. 11) through a small round aperture, *z*, and falling on a triangular glass prism, *x*, is by the refraction of the prism considerably dilated, and will exhibit on the opposite wall an oblong image, *a b*, called a spectrum, variously coloured, the extremities of which are bounded by semicircles, and the sides are rectilinear. The colours are commonly divided into seven, which, however, have various shades, gradually intermixing at their juncture. Their order, beginning from the side of the refracting angle of the prism, is red, orange, yellow, green, blue, purple, violet. The obvious conclusion from this experiment is, that the several component parts of solar light have different degrees of refrangibility,

and that each subsequent ray in the order above mentioned is more refrangible than the preceding.

As a circular image would be depicted by the solar ray unrefracted by the prism, so each ray that suffers no dilatation by the prism would mark out a circular image, y. Hence, it appears, that the spectrum is composed of innumerable circles of different colours. The mixture, therefore, is proportionable to the number of circles mixed together (fig. 12); but all such circles are mixed together, whose centres lie between those of two contingent circles, consequently the mixture is proportionable to the interval of those centres, i. e. to the breadth of the spectrum. If therefore the breadth can be diminished, retaining the length of the rectilinear sides, the mixture will be lessened proportionably, and this is done by the following process.

At a considerable distance from the hole, a, place a double convex lens, A B (fig. 13), whose focal length is equal to half that distance, and place the prism, x, behind the lens; at a distance behind the lens, equal to the distance of the lens from the hole, will be formed a spectrum, the length of whose rectilinear sides is the same as before, but its breadth much less; for the undiminished breadth was equal to a line subtending, at the distance of the spectrum from the hole, an angle equal to the apparent diameter of the sun, together with a line equal to the diameter of the hole; but the reduced breadth is equal to the diameter of the hole only; the image of the hole formed by the lens at the distance of double its focal length, is equal to the hole; therefore, its several images in the different kinds of rays are equal to the same, i. e. the breadth of the reduced spectrum is equal to the diameter of the hole.

A prism A B C, (fig. 14, Plate II.) placed in an horizontal position, would project the ray into an oblong form, as has been seen; apply another horizontal prism, A D B, similar to the former, to receive the refracted light emerging from the first, and having its refracting angle turned the contrary way from that of the former. The light, after passing through both prisms, will assume a circular form, as if it had not been at all refracted.

If the light emerging from the first prism be received by a second, whose axis is perpendicular to that of the former, it will be refracted by this transverse prism into a position inclined to the former, the red extremity being least, and the violet most removed from its former position; but it will not be at all altered in breadth.

Close to the prism A (fig. 15), place a perforated board, a b, and let the refracted light (having passed through the small hole) be received on a second board, c d, parallel to the first, and perforated in like manner; behind that hole in the second board place a prism, with its refracting angle downward, turn the first prism slowly about its axis, and the light will move up and down the second board; let the colours be transmitted successively, and mark the places of the different coloured rays on the wall after their refraction by the second prism, the red will appear lowest, the violet highest, the rest in the intermediate places in order. Here then the light being very much simplified, and the incidences of all the rays on the second prism exactly the same; the red was least refracted, the violet most, &c.

The permanency of these original colours appears from hence, that they suffer no manner of change by any number of refractions, as is evident from the last mentioned experiment; nor yet by reflection, for if any coloured body be placed in simplified homogeneous light it will always appear of the same colour of the light in which it is placed, whether that differ from the colour of the body or not; e. g. if ultra marine and vermilion be placed in a red light both will appear red; in a green light, green; in a blue light, blue, &c. It is, however, to be allowed, that a body appears brighter when in a light of its own colour than in another; and from this we see that the colours of natural bodies arise from an aptitude in them to reflect some rays more copiously and strongly than others; but lest this phenomenon should produce a doubt of the constancy of the primary colours, it is proper to assign the reason of it, which is this: that when placed in its own coloured light, the body reflects the rays of the predominant colour more strongly than any of those intermixed with it; therefore the proportion of the rays of the predominant colour to those of the others, in the reflected light, will be greater than in the incident light; but when the body is placed in a light of a different colour from its own, for a similar reason the contrary effect will follow, i. e. the proportion of the predominant colour to the others will be less in the reflected than in the incident light, and therefore as its splendor would be greater in the former case,

and would be less in the latter than if all the rays were equally reflected, the splendour of the predominant colour will be much greater in the former case than in the latter.

As a solar ray was separated into several others of different colours, so, on the contrary, from these homogeneous rays a ray of heterogeneous light may be compounded, perfectly corresponding both in appearance and properties with the solar rays.

The coloured rays (fig. 16), diverging from the prism are received by a double convex lens, at the distance of twice its focal length from the hole; at the same distance behind the lens, where they are collected by its refraction, they are received on a second prism, whose refracting angle is equal to that of the former; the divergence of the homogeneous rays that would otherwise ensue, is counteracted by the second prism, and they are made to proceed parallel to each other from the place of their intersection, and therefore are all compounded and mixed together in the emergent ray A B, which is exactly of the same appearance with the solar rays, and, by experiments made on it similar to those usually made in solar light, is found to possess the same properties.

Since then, 1. A solar ray may be resolved into several differently coloured rays; 2. Since their colours are immutable either by reflection or refraction, and therefore probably not generated in those operations; and 3. Since from the mixture of those coloured rays solar light may be formed, it seems an indisputable conclusion that the differently coloured rays do exist in solar light previously to any separation that takes place in experiments.

White is compounded of all the primary colours mixed in their due proportions, for if a solar ray be separated by the prism into its component parts, and at a proper distance a lens be so placed as to collect the diverging coloured rays again into a focus, a paper placed perpendicularly to the rays in this point will exhibit whiteness.

The same conclusion may be drawn from the experiment of mixing together paints of the same colours as the parts of the spectrum, and in the same proportion; the mixture will be white, though not of a resplendent whiteness, because the colours mixed are less bright than the primary ones; this may likewise be proved, by fixing pieces of cloth of all the seven different colours, on the rim of a wheel, and whirling it round with great velocity, it will appear to be white. Though seven different colours are distinguishable in the prismatic spectrum, yet, upon examining the matter with more accuracy, we shall see that there are, in fact, only three original colours, red, blue, and yellow; for the orange being situated between the red and yellow, is only the mixture of these two: the green, in like manner, arises from the blue and yellow; and the violet from the blue and red.

As the colour of a body, therefore, proceeds from a certain combination of the primary rays which it reflects; the combination of rays flowing from any point of an object will, when collected by a glass, exhibit the same compound colour in the corresponding point of the image. Hence appears the reason why the images formed by glasses have the colours of the objects which they represent.

The instance of the separation of the primary colours of light which seems most remarkable, is that of the RAINBOW. It is formed, in general, by the reflection of the rays of the sun's light from the drops of falling rain, though frequently it appears among the waves of the sea, whose heads, or tops, are blown by the wind into small drops, and it is sometimes seen on the ground, when the sun shines on a very thick dew. Cascades and fountains, whose waters are in their fall divided into drops, exhibit rainbows to a spectator, if properly situated during the time of the sun's shining; and water blown violently from the mouth of an observer, whose back is turned towards the sun, will, with care, produce the same phenomenon. See RAINBOW.

This appearance is also seen by moonlight, though seldom vivid enough to render the colours distinguishable; and the artificial rainbow may be produced even by candle-light, on the water which is ejected by a small fountain, or *jet d'eau*. All these are of the same nature, and dependent on the same causes, viz. the various refrangibility of the rays of light.

The colours observable on soap-bubbles, and the halos which sometimes surround the moon, are also referable to the same origin.

"Of the Eye, and the Nature of Vision." The eye is nearly of a spherical shape, and is composed of three different substances, called, 1. The aqueous, P (fig. 17). 2. The crystalline, R; and 3. The vitreous humours, V, enclosed by three principal

coats, which are formed by the expansion of the different component parts of the optic nerve, *viz.* the sclerotica, S S. 2. The choroides, D D; and 3. The retina, T T. The sclerotica is outermost; it is very strong, and the fore part, which is transparent, and somewhat prominent, is called the cornea, C. The choroides is next in order, and has a circular perforation, P, called the pupil, immediately behind the middle of the cornea: the part II. of the choroides, visible behind the cornea, is flat; it is called the iris, or uvea, and is differently coloured in different persons. The retina is the inmost coat, it extends round the eye till it meets the ciliary ligaments, Q Q, membranes proceeding from the choroides, and attached to the capsula or filament, which incloses the crystaline humour, R. The crystaline is the most dense of the three humours, and is in the shape of a double convex lens, whose fore part has the less curvature; the cavity between the cornea and the crystaline is occupied by the aqueous humour, which has rather the least density of the three, and the space between the bottom of the eye and the crystaline is filled by the vitreous humour, V.

Objects presented to the eye have their images painted on the back part of the retina, the rays of the incident pencils converging to their proper foci there by the refraction of the different humours; and for this office they are admirably adapted; for as the distance between the back and front of the eye is very small, and the rays of each of the pencils that form the image fall parallel, or else diverging on the eye, a strong refractive power is necessary for bringing them to their foci at the retina; but each of the humours, by its peculiar form and density, contributes to cause a convergence of the rays; the aqueous from its convex form; the crystaline by its double convexity and greater density than the aqueous; and the vitreous by a less density than the crystaline joined to its concave form.

These things are manifest from what has been already said. The structure of the eye is in general adapted to the reception of parallel rays; but as the distances of visible objects are various, so the eye has powers of accommodating itself to rays proceeding from different distances, by altering the distance of the crystaline from the retina, which is done by the action of the ciliary ligaments.

That this change of situation in the crystaline is adequate to such accommodation, may be thus shewn. Suppose a pencil of rays to diverge from a point, A, (fig. 18.) at a distance from the eye less than that which admits distinct vision in the usual situation of the humours: the rays would come to a focus, V, behind the retina, L M. Let the crystaline, O P, be brought forward, and, C V, the distance of the focus from the crystaline will be increased; but, because of the great proportion that, A C, the smallest distance that admits distinct vision has to, F C, the focal length of the crystaline, the distance, C G, of the crystaline from the retina will be more increased than C V, so that C G and C V may become equal, and thus the focus made to fall exactly on the retina.

These powers of accommodation are however limited, and the sight is said to be perfect when the eye can adapt itself to any distance within the usual limits, and when it cannot, vision is indistinct.

Defective sight arises from an incapacity of altering the position of the crystaline within the usual limits. 1. When it cannot be brought close enough to the cornea, near objects appear indistinct; to this defect people in years are generally subject. 2. Where the crystaline cannot be drawn sufficiently near to the retina, remote objects appear indistinct; this is the defect under which myopes, or short-sighted people, labour. In each of these cases the images of the different points in the object would be diffused over small circles on the retina; and so being intermixed and confounded with each other, would there form a very confused picture of the object: for in the former case (fig. 19), the image of any point would be formed behind the retina, as the refraction of the eye is not sufficiently strong to bring the rays (diverging so much as they do in proceeding from a near point) to a focus at the retina. This defect will therefore be remedied by a convex glass, *a b*, which makes the point whence the rays now proceed more distant than the object; therefore the rays falling on the eye will now diverge less than before, or else be parallel, and will of course be brought to a nearer focus, *viz.* at the retina.

In the latter case the image is formed before the retina (fig. 20) because the refractive power of the eye is too great to permit rays so little diverging (as they do in proceeding from a distant point) to

reach the retina before they are collected into a focus; in this case the defect is supplied by a concave glass, *a b*, which makes the point whence the rays diverge, nearer than the object; consequently, the rays falling on the eye will now diverge more than before, so as when refracted through the humours not to come to their focus before they reach the retina.

Spectacles are constructed on the above principles, concave for short-sighted, and convex for long-sighted people. See SPECTACLES and VISION.

"Of microscopes and other optical instruments." The impediments to the vision of very near objects arise from too great a divergence of the rays in each pencil incident on the eye, and are remedied by the microscope. This instrument is of two kinds: 1, refracting; and, 2, reflecting.

The refracting microscope is either single or compound. The former is a small double convex lens, of a short focal length; the object is placed in its focus, by which disposition the rays of each pencil emerging from the lens become parallel, and so are brought to their respective foci on the retina by the humours of the eye: the magnifying power of the instrument appears from hence.

The apparent lineal magnitude of an object seen with this instrument, is to its lineal magnitude seen with the naked eye, as the least distance that admits of distinct vision with the naked eye, to the focal length of the lens; for these magnitudes are as the angles under which the object appears, *i. e.* inversely as the distances at which it is viewed.

A compound microscope is composed of two double convex glasses, the broader next the eye. In this instrument the distance of the object from the object-glass is to be made greater than the focal length of that lens; then the image will be formed at the focus conjugate to the place of the object, and the eye-glass being placed at its own focal distance from the image, will make the rays emerge parallel to each other, and consequently produce distinct vision. See MICROSCOPE.

To enlarge the field of the compound microscope, it is usual to insert a broad lens, as in the astronomical telescope, between the object-glass and the image.

The reflecting microscope is thus constructed: In the extremity of a broad tube insert a concave speculum N U (fig. 21); a point O in its axis, whose distance from the vertex, V, is greater than the focal length of the concave, is the place for the object, whose image will consequently be formed at the focus, G, conjugate to the point O: at the distance of its own focal length, L G, place a double convex lens, *a b*, by which the image will be seen distinctly. The object is illuminated by light admitted into the tube through a space, P R, adjoining to the speculum; and the illustration of the object may be rendered more intense by a concave speculum, A B, which shall reflect the light so admitted to a focus at the place of the object.

A solar microscope is constructed in the following manner: In the inside of a tube is placed a convex lens, A B (fig. 22); and at a distance a little greater than its focal length, but less than double of it, is fixed some transparent coloured object, Q P, whose image will be painted much enlarged at the focus conjugate to the place of the object. A broad lens C D, is placed before the object to collect the solar rays, for the purpose of illuminating it more strongly, and consequently making the image more distinct and vivid. On the same principle is constructed the MAGIC LANTERN, which see.

The camera obscura is an instrument used to facilitate the delineation of prospects. It is constructed in the following manner: A C (fig. 23), represents a box of about a foot and a half square, shut on every side, except D C; O P is a smaller box placed on the top of the greater; M N is a double convex lens, whose axis makes an angle of 45° with B L, a plane mirror fixed in the box O P; the focal length of the lens is nearly equal to C S + S T, *i. e.* to the sum of the distances of the lens from the middle of the mirror, and of the middle of the mirror from the bottom of the larger box. The lens being turned toward the prospect would form a picture of it, nearly at its focus; but the rays being intercepted by the mirror will form the picture as far before the surface as the focus is behind it, *i. e.* at the bottom of the larger box, a communication being made between the boxes by the vacant space Q O. The draughtsman then putting his head and hands into the box through the open side, D C, and drawing a curtain round to prevent the admision of the light, which would disturb the operation, may trace a distinct outline of the picture that appears on the bottom of the box.

There is another kind of camera obscura, constructed thus. In the extremity of the

arm, P Q (fig. 24), that extends from the side of a small square box, B L, is placed a double convex lens, whose axis is inclined in an angle of 45° to a plane mirror B O: the focal length of the lens is equal to its distance from the side of the box O T; therefore, when the lens is turned towards the illuminated prospect, it would project the image on the side O T, if the mirror were removed, but this will reflect the image to the side M L, which is as far distant from the middle of the mirror, as this is from the side O T; it is there received on a piece of glass, rough at the upper side and smooth at the lower, and appears in its proper colours on the upper side of the plate. It is evident that in each of these instruments the image is inverted with respect to the object.

M S is a lid to prevent the admission of light during the delineation of the picture, and others for the same purpose are applied to the sides M R and N L.

Dr. Wollaston has recently invented a portable instrument for drawing in perspective, to which he has given the name of Camera Lucida. In this instrument two plane reflectors are fixed at such angles with regard to each other, that the objects intended to be delineated are seen after reflection from the second mirror, as though they were on the same plane as that whereon the paper is placed which is to contain the drawing. These plane reflectors may be either common mirrors with a silver coating at the back of each, or two contiguous faces of a glass prism, in which latter case the image will be produced by what is called prismatic reflection. In either case the most convenient position, in which the reflecting surfaces can be arranged, will be such as will cause the rays proceeding directly from the object and falling as incident rays upon the first surface, after reflection from thence to the second, to emerge from that second reflecting surface in angles of 90 degrees, with the direction of the original incident rays; for in these circumstances vertical objects may be projected upon a horizontal plane, and the instrument will be adapted to drawing upon a horizontal surface. Now, if two plane mirrors are used, the incident rays upon the first will make right angles with the emergent rays from the second, when those mirrors are fixed so as to make angles of either 45 or 135 degrees with each other. In this case the mirror which first receives the rays from the object may be entirely silvered at its back; but the second mirror is only to have a sufficient portion silvered to reflect the image of the proposed object to the eye; and thus to allow the paper, on which the drawing is to be made, to be seen either through an opening of the silvering or past the edges of the same, by one portion of the eye, while the double reflected object is seen in the silvering by the other portion of the same eye. When prismatic reflection is employed, the prism must not be triangular as usually constructed, but quadrangular, and the two reflecting surfaces (to produce an angle of 90 degrees between the first incident and second emergent rays) must make an angle of 135 degrees, while the opposite angle must be one of 90 degrees, and the other two angles may be either respectively equal or unequal at pleasure; then one of the faces which make right angles with each other is to be turned towards the object or objects to be delineated, and the rays after passing through that surface and reflection from the two next faces, will emerge from the fourth under the proposed angle. The mirrors or other reflecting surfaces are mounted in a proper frame, and supported at a suitable distance from the paper intended to receive the drawing; and, when necessary, either a double concave or a double convex glass may be fixed in the frame and properly adjusted, to produce distinct vision when the apparatus is used by short-sighted or long-sighted persons respectively. These concave or convex glasses may conveniently be made of twelve inches focal length; the instrument must then be supported at the distance of twelve inches from the paper; a distance which is convenient enough in other respects.

Dr. Wollaston has himself published a description of this instrument, in Nicholson's Philosophical Journal, where he likewise institutes a comparison between the Camera Obscura and the Camera Lucida. The objection to the Camera Obscura are, 1. That it is too large to be carried about with convenience. The Camera Lucida is as small and portable as can be wished. 2. In the former, all objects that are not situated near the centre of view are more or less distorted. In this, there is no distortion; so that every line, even the most remote from the centre of view, is as straight as those through the centre. 3. In that, the field of view does not extend beyond 30°, or at most 35°, with distinctness. But in the Camera Lucida as much as 70° or 80° might be included in one view.

Dr. Wollaston remarks further, that by a

proper use of the same instrument every purpose of the pentagraph may also be answered; as a painting may be reduced in any proportion required, by placing it at a distance in due proportion greater than that of the paper from the instrument. In this case a lens becomes requisite for enabling the eye to see at two unequal distances with equal distinctness; and in order that one lens may suit for all these purposes, there is an advantage in varying the height of the stand according to the proportion in which the reduction is to be effected.

OPTION, in law, every bishop, whether created or translated, is bound immediately after confirmation, to make a legal conveyance to the archbishop, of the next avoidance of such dignity or benefice belonging to the see, as the said archbishop shall choose, which is therefore called an option.

OR, in heraldry, denotes yellow, or gold colour. In the coats of noblemen it is blazoned topaz; and in those of sovereign princes, sol. It is represented in engraving by small points or dots, scattered all over the field or bearing.

ORATORIO, in music, a species of musical drama, originally an imitation of the serious opera, the subject of which is generally taken from scripture, and can be only treated properly by music of the sublimest style.

ORBIT, in astronomy, the path of a planet or comet, or the curve that it describes in its revolution round its central body: thus the Earth's orbit is the curve which it describes in its annual course, and usually called the ecliptic. The orbits of all the planets are ellipses having the Sun in their common focus; in which curve they move according to an invariable law. See ASTRONOMY. However, the orbit of the Earth is considerably disfigured by the action of the Moon; as is also the orbit of Saturn by the action of Jupiter, when they happen to be in conjunction. Though the orbits of the planets be elliptical, not circular, yet that they are very little so, even in the most eccentric orbit, as that of Mercury, will appear by comparing their eccentricities with their mean distances from the Sun. The orbits of the planets are not all in the same plane with the ecliptic, but are variously inclined to it, and to each other; but still the plane of the ecliptic intersects the plane of the orbit of every other planet, in a right line which passes through the Sun, called the line of the nodes, and the points of intersection of the orbits themselves are called the nodes.

ORCHESTRA, in music, that enclosed part of the theatre between the audience and the curtain; in which the instrumental performers sit.

ORCHIDEÆ, in botany, the seventh order in Linnæus's Fragments of a Natural Method, consisting of Orchis, and the plants that resemble it in habit, powers, and sensible qualities. The flowers are hermaphrodite, and placed at the summit of the stalk, either in a spike, or in a panicle. Each flower is accompanied with a leaf that is smaller than the other leaves, and forms a sort of sheath round the stalk. The petals are five in number, and very irregular. The flowers of the different species are remarkably various and singular in their shape, resembling different kinds of animals or insects.

ORCHIS, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary a horn or spur behind the flower. There are fifty species. Among which we shall notice the O. bifolia, butterfly orchis. This plant has ovate bulbs, tapering to a point at the base; thick fleshy fibres proceed above them from the base of the stem; one of these bulbs is always wrinkled and withered, whilst the other is plump and delicate; the first is the parent of the actual stem; the second is an offset, from the centre of which the stem of the succeeding year is destined to arise. Such are the means that nature uses, not only to disseminate plants, but to enable them to change their place, and thus to draw in fresh nutriment. The second root is always about half an inch from the centre of the first, so that in twenty years the plant will have marched ten inches from the place of its birth. This mode of increase is particularly necessary in a family of plants that rises with great difficulty, and very seldom by seed. O. conopsea, long-spurred Orchis, is distinguished by the remoteness of the cells or cases in which the stamens are lodged, and again by the colour of the corolla, the great length of the spur, the delicious fragrance of its flowers, vying with that of the honeysuckle, and particularly by the unusual structure of its flowers. Below the stigma, which is remarkably well defined in this species, there is a circular opening between the cavities containing the stamens; just above the stigma is a very con-

spicuous ridge; the stamens soon change to a brownish hue; the anthers are club shaped, and are divided as in most others, the gland at the base of the filament is of a circular form, with a cavity on its inner side: the roots of this species are well caculated for making salep.

ORDEAL, was anciently a form of trial, and was of two sorts; either fire ordeal, or water ordeal; the former being confined to persons of higher rank, the latter to the common people. Both these might be performed by deputy, but the principal was to answer for the success of the trial; the deputy only venturing some corporeal pain for hire, or perhaps for friendship. Fire ordeal was performed either by taking up in the hand a piece of red hot iron, of one, two, or three pounds weight; or else by walking barefoot and blindfold over nine red hot ploughshares, laid at unequal distances; and if the party escaped unhurt, he was adjudged innocent; if not, he was condemned as guilty. Water ordeal was performed, either by plunging the bare arm up to the elbow in boiling water, and escaping unhurt thereby, or by casting the person suspected into a river or pond of water; and if he floated, without any action of swimming, it was deemed an evidence of his guilt; but if he sunk he was acquitted. This trial by ordeal was abolished by parliament anno 3 Henry III.

ORDER, in architecture, is a system of the several members, ornaments and proportions of columns and pilasters; or a regular arrangement of the projecting parts of a building, especially the column, so as to form one beautiful whole. There are five orders of columns, of which three are Greek, *viz.* the Doric, Ionic, and Corinthian, and two Roman, the Tuscan and Composite. The three Greek orders represent the three different manners of building, *viz.* the solid, the delicate, and that which is between the two. See ARCHITECTURE.

ORDER, in astronomy. A planet is said to go according to the order of the signs when it is direct, proceeding from Aries to Taurus, thence to Gemini, &c. It goes contrary to the order of the signs when it is retrograde, or goes backward from Pisces to Aquarius.

ORDER, in geometry, is denominated from the rank or order of the equation by which the geometrical line is expressed: thus the simple equation, or first power, denotes the first order of lines, which is a right line: the quadratic equation, or second power, defines the second order of lines, which are the conic sections and circle: the cubic equation, or third power, defines the third order of lines; and so on. Or the orders of lines are denominated from the number of points in which they may be cut by a right line. Thus the right line is of the first order, because it can be cut only in one point by a right line: the circle and conic sections are of the second order, because they can be cut in two points by a right line; while those of the third order are such as can be cut in three points by a right line.

ORDER, in botany, the first subdivision of a class in the Linnæan system, founded on the number of styles or female organs. The orders of Linnæus are all expressed by a single term, which, like the names of the classes, is of Greek etymology, and is significant of the character of the order to which it is applied. The names of these orders are often different in different classes, because the same idea predominates in their institution.

ORDINANCE, or *Ordonnance*, a law, statute, or command of a sovereign or superior.

ORDINARY, in the civil law, signifies any judge that hath authority to take cognizance of causes in his own right, as he is a magistrate, and not by deputation; but in the common law it is taken for him who has exempt and immediate jurisdiction in causes ecclesiastical.

ORDINARY, or *honourable Ordinary*, in heraldry, a denomination given to certain charges properly belonging to that art. The honourable ordinaries are ten in number; *viz.* the chief, pale, bend, fesse, bar, cross, saltier, chevron, bordure, and orle. For which see HERALDRY, &c.

ORDINATES, in geometry, are right lines drawn parallel to each other, and cutting the curve in a certain number of points. Parallel ordinates are usually all cut by some other line, which is called an absciss. When this line is a diameter of the curve, the property of the ordinates is then the most remarkable; for, in the curves of the first kind, or the conic sections and circle, the ordinates are all bisected by the diameter, making the part on one side of it equal to the part on the other side of it; and in the curves of the second order, which may be cut in three points by an ordinate, then of the three parts of the ordinate, lying between these three inter-

sections of the curve and the intersection with the diameter, the part on one side the diameter is equal to both the two parts on the other side of it. And so for curves of any order, whatever the number of intersections may be, the sum of the parts of any ordinate, on one side of the diameter, is equal to the sum of the parts on the other side of it. The use of ordinates in a curve, and their abscisses, is to define or express the nature of a curve by means of the general relation or equation between them; and the greatest number of factors, or the dimensions of the highest term, in such equation, is always the same as the order of the line; that equation being a quadratic, or its highest term of two dimensions, in the lines of the second order, being the circle and conic sections; and a cubic equation, or its highest term containing three dimensions, in the lines of the third order, and so on. Thus, y denoting an ordinate and x its absciss, also $a\ b\ c$, &c. given quantities: then $y^2 = ax^2 + bx + c$ is the general equation for the lines of the second order; and $xy^2 - ey = ax^3 + bx^2 + cx + d$ is the equation for the lines of the third order, and so on.

ORDINATION, the act of conferring holy orders, or of initiating a person into the priesthood by prayer, and the laying on of hands. Ordination has always been esteemed the principal prerogative of bishops, and they still retain the function as a mark of spiritual sovereignty in their diocese. Without ordination, no person can receive any benefice, parsonage, vicarage, &c. A clerk must be twenty-three years of age before he can have any share in the ministry; and twenty-four before he can be ordained, and by that means be permitted to administer the sacraments. A bishop, on the ordination of clergymen, is to examine them in the presence of the ministers who assist him at the imposition of hands: and in case any crime, as drunkenness, perjury, forgery, &c. be alleged against any one that is to be ordained, either priest or deacon, the bishop ought to desist from ordaining him. The person to be ordained is to bring a testimonial of his life and doctrine to the bishop, and give an account of his faith in Latin, and both priests and deacons are obliged to subscribe the thirty nine articles.

ORDNANCE, a general name for all sorts of great guns used in war.

Ordnance, *office of*, an office kept within the Tower of London, which superintends and disposes of all the arms, instruments, and utensils of war, both by sea and land, in all the magazines, garrisons, and forts, in Great Britain.

The officers of the ordnance are: 1. The Master General, from whom are derived all orders and dispatches relating to the same. 2. The Lieutenant General, who receives orders from the Master General, and sees them duly executed; orders the firing of guns on days of rejoicing, and sees the train of artillery fitted out when ordered to the field. 3. The Surveyor General, who has the inspection of the ordnance, stores, and provisions of war in the custody of the store-keepers: he allows all bills of debt, keeps a check on labourers, &c. 4. The Treasurer, through whose hands passes the money of the whole office, as well for payment of salaries as debentures; as also a Clerk of the Ordnance, and a Clerk of the Deliveries, for which see the articles Clerk, *of the ordnance*, &c.

ORES, in mineralogy. An ore is a metal in the state in which it exists in the earth. It may be either native, that is pure, and uncombined with any other substance, or alloyed with another metal; or in a state of an oxide, or a sulphuret, or a carburet, or of a metallic salt. It is also mixed in most instances with various earthy minerals. The ores of metals may be analyzed in two modes, in the humid, and the dry way. The first is effected with the aid of acids, and of other liquid agents, and may often be accomplished by very simple means, and without the aid of a bulky and expensive apparatus. If sulphur be present, it impedes the action of acids, and should be separated by roasting the ore on a muffle, or by projecting it mixed with twice its weight of nitre into a red-hot crucible, washing off the alkali afterwards with hot water. No solvent will act upon all the metals. Thus nitric acid does not act on gold and platina; and the nitro-muriatic acid, which dissolves these metals, has no solvent action on silver. Hence the necessity of varying the solvent according to the nature of the ore, under examination. We shall give a few instances by which the reader will understand the theory, and may be enabled to verify the facts by practice.

For "ores of gold and platina," the nitro-muriatic acid is the most proper solvent. A given weight of the ore may be digested with this acid, as long as it extracts any thing. The solution is to be evaporated to

dryness, in order to expel the excess of acid, and dissolved in water. The addition of a solution of tin and muriatic acid will shew the presence of gold by a purple precipitate; and platina will be indicated by a precipitate, on adding a solution of muriate of ammonia. When gold and platina are both contained in the same solution, they may be separated from each other by the last mentioned solution, which throws down the platina, but not the gold. In this way platina may be detached also from other metals.

For extracting "silver" from its ores, the nitric acid is the most proper solvent. The silver may be precipitated from nitric acid by muriate of soda. Every hundred parts of the precipitate contains seventy-five of silver. But, as lead may be present in the solution, and this metal is also precipitated by muriate of soda, it may be proper to immerse in the solution, a polished plate of copper. This will precipitate the silver, if present, in a metallic form. The muriate of silver is also soluble in liquid ammonia, which that of lead is not.

"Copper ores" may be analyzed by boiling them with five times their weight of concentrated sulphuric acid, till a dry mass is obtained, from which water will extract the sulphate of copper. This salt is to be decomposed by a polished plate of iron, immersed in a dilute solution of it. The copper will be precipitated in a metallic state, and may be scraped off and weighed. If silver be suspected with copper, nitrous acid must be employed as the solvent; and a plate of polished copper will detect the silver.

"Iron ores" may be dissolved in dilute muriatic acid, or, if the metal be too highly oxydized to be dissolved by this acid, they must be previously mixed with one-eighth of their weight of powdered charcoal, and calcined in a crucible for an hour. The iron is thus rendered soluble. The solution must then be diluted with ten or twelve times its quantity of water, previously well boiled, to expel the air, and must be preserved in a well-stopped glass bottle for six or eight days. The phosphate of iron will within that time be precipitated, if any be present, and the liquor must be decanted off. The solution may contain the oxides of iron, manganese, and zinc. It may be precipitated by carbonate of soda, which will separate them all. The oxide of zinc will be taken up by a solution of pure ammonia; distilled vinegar will take up the manganese, and will leave the oxide of iron. From the weight of this, after ignition, during a quarter of an hour, twenty-eight per cent. may be deducted.

"Tin ores." Boil 100 grains, in a silver vessel, with a solution of 600 grains of pure potash. Evaporate to dryness, and then ignite moderately for half an hour. Add boiling water, and if any portion remain undissolved, let it undergo a similar treatment. Saturate the alkaline solution with muriatic acid, which will throw down an oxide of tin. Let this be redissolved by an excess of muriatic acid: again precipitated by carbonate of soda; and being dried and weighed, let it, after lixiviation, be once more dissolved in muriatic acid. The insoluble part consists of silix. Into the colourless solution, diluted with two or three parts of water, put a stick of zinc, round which the reduced tin will collect. Scrape off the deposit, wash, dry, and fuse it under a cover of tallow in a capsule placed on charcoal. A button of pure metallic tin will remain at the bottom, the weight of which, deducted from that of the ore, indicates the proportion of oxygen. The presence of tin in an ore is indicated by a purple precipitate, on mixing its solution in muriatic acid with one of gold in nitro-muriatic acid.

"Lead ores" may be analyzed by solution in nitric acid, diluted with an equal weight of water. The sulphur, if any, will remain undissolved. Let the solution be precipitated by carbonate of soda. If any silver be present, it will be taken up by pure liquid ammonia. Wash off the excess of ammonia by distilled water; and add concentrated sulphuric acid, applying heat, so that the muriatic acid may be wholly expelled.

"Mercury" may be detected in ores that are supposed to contain it, by distillation in an earthen retort with half their weight of iron filings or lime. The mercury, if any be present, will rise and be condensed in the receiver.

"Ores of zinc" may be digested with the nitric acid, and the part that is dissolved boiled to dryness, again dissolved in the acid, and again evaporated. By this means the iron, if any be present, will be rendered insoluble in dilute nitric acid, which will take up the oxide of zinc. To this solution add pure liquid ammonia, in excess, which will separate the lead and iron, if any should have been dissolved; and the excess of alkali will retain the oxide of zinc. This

may be separated by the addition of an acid.

"Antimonial ores." Dissolve a given weight in three or four parts of muriatic, and one of nitric acid. This will take up the antimony, and leave the sulphur, if any. On dilution with water the oxide of anti-mony is precipitated, and the iron and mercury remain dissolved. Lead may be detected by sulphuric acid.

"Ores of cobalt" may be dissolved in nitro-muriatic acid. Then add carbonate of potash, which, at first, separates iron and arsenic. Filter, and add a further quantity of the carbonate, when a greyish-red precipitate will fall down, which is oxide of cobalt. The iron and arsenic may be separated by heat, which volatilizes the arsenic. Cobalt is also ascertained, if the solution of an ore in muriatic acid give a sympathetic ink. See Klaproth's Essays.

To analyze ores in the dry way, a method which affords the most satisfactory evidence of their composition, and should always precede the working of large and extensive strata, a more complicated apparatus is required. An assaying furnace, with muffles, crucibles, &c. are absolutely necessary. See Assaying; Laboratory, &c.

The reduction of an ore requires frequently previous roasting, to expel the sulphur and other volatile ingredients; or this may be effected by mixing the powdered ore with nitre, and projecting the mixture into a crucible. The sulphate of potash, thus formed, may be washed off, and the oxide must be reserved for subsequent experiments. As many of the metals retain their oxygen so forcibly, that the application of heat is incapable of expelling it, the addition of inflammable matter becomes expedient. And, to enable the reduced particles of metal to agglutinate and form a collected mass, instead of scattered grains, which would otherwise happen, some fusible ingredient must be added, through which, when in fusion, the reduced metal may descend, and be collected at the bottom of the crucible. Substances that answer both these purposes are called fluxes. The alkaline and earthy part of fluxes serve also another end; viz. that of combining with any acid which may be attached to a metal, and which would prevent its reduction, if not separated. The ores of different metals, and different ores of the same metal, require different fluxes. See Flux. The ore, after being roasted, if necessary, is to be well mixed with three or four times its weight of the flux, and put into a crucible, with a little powdered charcoal over the surface. A cover must be luted on, and the crucible exposed to the necessary heat in a wind-furnace. Ores of iron, as being difficultly reduced, require a very intense fire. Those of silver and lead are metallized by a lower heat. The metal is found at the bottom of the crucible, in the form of a round button. The volatile metals, as mercury, zinc, arsenic, tellurium, and osmium, it is obvious, ought not to be treated in the above manner, and require to be distilled with inflammable matters in an earthen retort. See Kirwan's Mineralogy.

ORGAN. Having, under the article Musical *instruments*, given a pretty full account of this instrument, we shall here only give a description, with figures, of the barrel-organ. See Plate I. Barrel Organ, and Plate II. parts of ditto.

The barrel-organ is generally portable, and is so contrived, that the same action of the hand, which turns the barrel, supplies the wind, by giving motion to the bellows: it consists of three principal parts: 1. The pipes, by which the sound is produced. 2. The bellows, supplying them with air. 3. The barrel and keys, by which the pipes are sounded at proper intervals. The pipes are of two kinds, of metal and of wood: the wooden ones are a square trunk of deal wood, A B, (*fig.* 5) closed at one end by a plug of wood, D, and at the other by a piece of wood, E, containing a crooked passage to bring air to the pipe, through the short tube, F; *a* is a piece of oak board, glued to the block, E, and hollowed out to communicate with the crooked passage in it, and leaving a small crack, between it and the edge of the block, E, through which the air issues in one continued stream; in its passage it is divided by the edge of one side of the trunk, A, which is cut as sharp as possible for that purpose, and which is exactly in the same line with the orifice whence the air is emitted.

The sound is produced by the vibration of the air which is contained in the trunk, A, and by increasing or diminishing the length of the pipe, the tone is altered at pleasure to bring it to the proper note it is to perform when placed in the instrument: this is done by sliding the plug, D, up or down in the pipe.

A metal pipe, a section of which is shown in fig. 6, is nearly the same in its operation, though different in its construction. It is a

cylindric tube, of a mixture of lead and tin; A B, (fig. 6) open at one end, and nearly closed at the other by a lump of the same metal, E, which is circular for about two-thirds round, and fits the end of the pipe; the other third is a straight edge: the upper edge of the conical pipe, F, is bent to be parallel to this, and thus forms a small cleft similar to the wooden one for the passage of the air, the lower edge of the cylindrical pipe, A B, is bent into the line of the cleft and cut sharp, to divide the current of air; these pipes are open at top, and are brought to tune by bending the pipe at the top, and thus altering its bulk: *a* is a piece of metal, called the ear, soldered upon the pipe at each end of the cleft, to prevent the stream of air being dispersed before it meets the sharp edge of the pipe, B A; in the small pipes this is not applied.

The bellows of the organ are double, as shewn in fig. 1, Plate I; that is, they are two distinct pairs, E, F, connected together at their hinge; so that when one is opening, and filling with air, the other is forcing its air out into the regulator, D; the bellows receive their motion by a rod, *d*, from a crank, *a*, on a spindle which comes through the box, in which the machine is enclosed, and has a handle on it by which it is turned. The regulator, D, is exactly similar to another pair of bellows, and is filled with air from the bellows, E F, below it, through two valves in the bottom board over the bellows; from this regulator the air proceeds through the passage, *b e f*, (seen better in the section), fig. 2, &c.

Fig. 2, Plate I, to a long trunk, *g*, going under the pipes called the air-chest, which communicates with them by a small valve, *h*, under each it is kept shut by a small wire spring, and is opened by a wire fixed to the end of a rod, G; above the valve, the passage enlarges, and goes under two small wooden sliders or stops, *n m*, and from thence in two distinct passages to the wooden and metal pipes, N M.

The air-chest, *g*, is common to all the pipes, and each pair (of wooden and metal pipes) has a valve, *h*, and spring to themselves; the small passage above each valve belongs to each pair of pipes, and has no connection with the other; the two stops belong to all the pipes; *m*, to the metal, and *n*, to the wooden ones; they are long slips of wood drilled with so many holes as there are pipes, and at the same intervals, (the disposition of the pipes is shown in fig. 3, which is a plan of the whole instrument put together); so that when the holes are over the passages, the air has free communication from the valve to the pipes; but when the stops are drawn out, the interval between each hole applies itself to the holes under the pipes, and thus stops the passages.

We now come to describe the apparatus which opens the valves, *h*, at the proper time, to perform the note of a piece of music.

The axle, on which the crank, *a*, (fig. 1, 2, and 3) is formed, has an endless screw, *o*, (fig. 3,) cut upon it to turn a wheel, *p*, by the teeth cut in its circumference; this wheel is in the same piece with a cylindric barrel, H H, shown separately (in fig. 4, Plate II); it has a great number of short pins stuck in it, which, as it revolves upon its pivots, catch the ends of a number of small levers called keys, *r r r*, and raise them; this depresses the other, *t t t*, ends, which are attached to the rods, G, and consequently open the valves. There are as many of the levers, or keys, as there are pipes, each answering to a different note of the gamut; the pins in the barrel are so disposed, as to lift the keys in the same order and time as any piece of music for which the barrel has been previously made. The keys all turn upon one wire, as a centre, and to prevent their shifting sideways; and by that means missing the pins in the barrel intended for them, they move in small notches, cut by a saw in two pieces of brass plate, which are screwed to the edge of a piece of wood, K, and project below it; the wire which forms the centre for the keys is also fixed to the piece of wood, K, which is called the key-frame. A number of small pieces of mahogany are fixed to the keys at *t*, and to these the rods, G, are jointed by a piece of leather glued to both: *v v*, are small screws going through the key-frame, and touching the piece of wood, *t*, their use is to adjust the levers, so that the ends, *r r*, shall form one straight line.

The key-frame is not fastened down to the frame of the machine, but has a piece of iron plate, *w*, fastened to each end, and turning upon screws fixed to the frame of the instrument upon which the whole key-frame can be fitted as a centre; two screws through its ends, resting their points upon the frame, support it, and by screwing these out, the whole frame can be raised or lowered, to adjust the ends of the keys the proper distance from the centre of the barrel, H.

By inspecting the plan and elevation, (fig. 1 and 3) it will be seen, that the barrel is longer than the set of keys, by the distance of one of the keys from the other, the barrel can be moved along endways this quantity, and for this purpose it is mounted in a frame, (fig. 4) which slides in a groove, shown in the section (fig. 2); a small pin, P, (fig. 4) is fastened to the frame, and comes through the case of the instrument; it has notches cut in it which receives the sharp edge of a bolt, L, (fig. 7) fixed there, and which holds the barrel in any place it is set. By moving the barrel endways a short distance, an entire new set of pins is presented to the keys, *r r*, which pins are disposed differently to the former ones, and consequently play a different tune; there are often five different sets, and as many notches, on the pin, P, (fig. 1). Without some contrivance when the barrel is moved endways, its pins might catch some of the keys, and break or bend them: to avoid this, the bolt, P, which confines the barrel, and prevents it being moved either way, is held down by another bolt, R, (fig. 7) sliding across the end of it; this bolt has a pin fastened to the back of it, which goes through the case of the instrument, (marked *x*, fig. 2 and 3) and when drawn back, presses down the end of a lever, *y*, the other end of which lifts up the key-frame, and thus raises the keys up clear of the pins in the barrel, before it can be moved endways to play another tune.

The regulator, D, is pressed down by two wire springs, which equalize the pressure upon the air contained in it, when, by the bellows forcing in more air than the pipes require, and consequently it accumulates in the regulator, it lifts up its lid, and the handle of a small valve, *z*, seen in the elevation, (fig. 1) is pushed against a part of the frame; this opens the valves, and allows the air to escape, until the regulator sinks by the action of the two wire springs.

From what we have said, a description of the operation of the instrument will be scarcely necessary. By turning the handle, the crank, *a*, works the bellows, and supplies the air to the pipes; the endless screw turns the barrel, and its pins lift up the keys at the proper time, opens the valves, and admits the air into the pipes. When soft music is to be played, the stop, *m*, (fig. 2) which has a handle coming through the case, is drawn out, and the other shoved in; this stops the passages to the wooden pipes, and opens the metal ones; for fuller music, the stop, *m*, is pushed in, and *n* drawn out; the wooden pipes are then used, and, for very grand and loud music, both sets are used, by drawing out both stops, and when both are in the sound-cases, though the handle is still turned. For changing the tune, the bolt, R, is drawn back, this raises the key-frame; the other bolt is then drawn back, and the pin, P, moved in or out to another notch; the bolts are then to be returned. Several barrels are adapted to the same organ, to perform a great variety of tunes.

ORGANICAL, in the ancient music, was that part performed by instruments. The organical comprehended three kinds of instruments, *viz.* the wind instruments, as trumpets, flutes, hautboys, &c.; stringed instruments, as lutes, lyres, violins, harpsichords, &c.; and pulsative instruments, or those played by beating with the hands or sticks, as drums, &c.

ORGANICAL *description of curves*, is the description of them upon a plane by means of instruments, and commonly by a continued motion. The most simple construction of this kind is, that of a circle, by means of a pair of compasses. The next is that of an ellipse by means of a thread and two pins in the foci, or the ellipse and hyperbola, by means of the elliptical and hyperbolic compasses.

ORGANZINE, in commerce, a description of silk usually imported from Italy into this country. It is of the utmost importance to the manufacturer, as none of the principal articles could be fabricated without it; and the Italians aware of this, long kept the art of throwing it a most profound secret. It was introduced into this country by the enterprize and skill of Messrs. Thomas and John Lombe, the latter having at the risk of his life, and with wonderful ingenuity, taken a plan of one of these complicated machines, in the King of Sardinia's dominions, from which, on his return, they established a similar set of mills in the town of Derby; and in consideration of the great hazard and expense attending the undertaking, a patent was granted to Sir Thomas Lombe, in 1718, for securing to him the exclusive privilege of working organzine for the term of 14 years; but the construction of buildings and engines, and the instruction of the workmen took up so much time, that the 14 years were nearly expired before he could derive any advantage from it, in consequence of which he petitioned parliament, in 1731, to grant him a further

term; but parliament considering it an object of national importance, granted him the sum of 14,000*l.* on condition that he should allow a perfect model of the machinery to be taken, and deposited in the Tower of London for public inspection. Similar mills were, in consequence, set up in different parts of the country; but owing to the difficulties that were experienced in procuring raw silk of the proper size for organzine, the exportation of which from Italy was prohibited, and to the mills having subsequently found employment for other purposes, the quantities worked into organzine, for many years, bore scarcely any proportion to the imports from Italy; it has, however, been since revived and improved, in consequence of which it is now carried to a very considerable extent.

The process which the silk undergoes to bring it into this state, consists of six different operations: 1. The silk is wound from the skein upon bobbins. 2. It is then sorted. 3. It is spun, or twisted, on a mill in the single thread. 4. Two threads thus spun are doubled, or drawn together through the fingers of a woman, who at the same time cleans them by taking out the slubs which may have been left in the silk by the negligence of the foreign reeler. 5. It is then thrown by a mill, that is, the two threads are twisted together either slack or hard, as the manufacture may require; and it is wound at the same time in skeins upon a reel. 6. The skeins are sorted according to their different degrees of fineness, and then the process is complete.

Organzine was for many years made only from Italian silk, but when considerable improvements were made in the culture of silk in India, it suggested the possibility of throwing some of the finer silks of Bengal into organzine. The experiments of individuals were not very satisfactory, but in the beginning of 1794, the East India Company took up the subject with the view of increasing the annual consumption of Bengal silk in this country; and having it in their power to select from their total import the silks most proper for this purpose, they have been enabled, at each subsequent sale, to put up from 80 to 100 bales of good Bengal organzine. It has been adopted successively in several branches of the manufacture; and in the year 1808, when the prohibition of exportation from Italy produced a scarcity of the silks of that country, attempts were made to substitute Bengal organzine for all the purposes, to which Italian organzine was applied; the result, however, appeared to be that, for some particular articles, Italian organzine possesses peculiar properties not to be found in any other kind of silk.

ORGASM, a quick motion of the blood, whereby the muscles are made to move with great force.

ORGUES, in the military art, are thick long pieces of wood pointed at one end, and shod with iron, clear one of another; hanging each by a particular rope, or cord, over the gate-way of a strong place, perpendicularly, to be let fall in case of an enemy. Their disposition is such, that they stop the passage of the gate, and are preferable to herses or portcullises; because these may be either broke by a petard, or they may be stopped in their falling down; but a petard is useless against an orgue, for if it break one or two of the pieces, they immediately fall down again, and fill up the vacancy; or if they stop one or two of the pieces from falling, it is no hindrance to the rest.

ORIGANUM, in botany, *marjoram*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: strobile four-cornered, spiked, collecting the calyxes. There are twelve species, with several varieties.

ORILLON, in fortification, is a small rounding of earth faced with a wall; raised on the shoulder of those bastions that have casemates, to cover the cannon in the retired flank, and prevent their being dismounted by the enemy.

ORIOLUS, the *oriole*, in natural history, a genus of birds of the order Picæ. Generic character: bill conic, convex, very sharp and strait; mandibles equally long; nostrils small, and lodged in the base of the bill, and partly covered; tongue divided and sharp-pointed. These birds are natives of America, are clamorous and voracious, appear in flocks, feed on fruits and grain, and frequently have pensile nests. Latham enumerates forty-five species; Gmelin fifty. We shall notice only those which follow:

O. persicus, or the black and yellow oriole. A variety of this species, somewhat larger than a blackbird, and an inhabitant of South America, is the bird rendered remarkable for building nests in the form of an alembic, and nearly eighteen inches long, of dry grass, hog's bristles, and horsehair, or, what is called in that country, old man's beard, a substance very like the hair

of horses. The bottom of this nest is hollow for the length of a foot, the remainder or upper part, for the space of six inches, is solid, and it is suspended at the extremity of a branch. It is particularly fond of building on trees, near houses, and several hundreds of these nests have occasionally been seen on a single tree.

O. icterus, or the Banana bird, is found in all the Caribbee islands, feeding on insects, and hopping like a magpie. These birds are domesticated in America, for the destruction of insects. In a state of nature, four or five will attack a large bird, and appear, after tearing it in pieces, to divide the spoil with great discrimination. They will occasionally attack men. Their nests are formed and suspended like those of the former species, to guard against snakes and other animals.

The oriolus of Baltimore, or the Baltimore bird, is called by the natives, the fire-bird, and, when its feathers are most brilliant, naturally excites the idea or sensation of fire. These birds form pensile nests, secure from all depredation. They are about seven inches long.

O. galbula, or the golden oriole, is as large as a blackbird, and of a fine golden yellow, with wings almost entirely black. It is common in several parts of Europe, particularly in France; but not seen, so far north even as England. It is supposed to winter in Africa. Its nest is pensile, and the female is extremely attentive to her young, fearing no enemy in their defence, suffering herself to be taken in the nest with them, and continuing to sit over them in the cage till she dies. It feeds on insects and fruits, and is considered as a delicacy for the table.

For the red-rumped oriole, see Aves, Plate X. fig. 6.

ORION, in astronomy, a constellation of the southern hemisphere, consisting of thirty-seven stars, according to Ptolemy; of sixty-two, according to Tycho; and of no less than eighty, in the Britannic catalogue. The lately improved telescopes have discovered several thousand stars in this constellation: of these, there are two of the first magnitude, four of the second, and several of the third and fourth. The stars of the first magnitude are Regel and Betelguese. Those of the second, are Bellatrix, on the left shoulder, and three in the belt; lying nearly in a right line, and at equal distances from each other.

ORNITHOGALUM, in botany, *Star of Bethlehem*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: corolla six-petalled, upright, permanent, spreading above the middle; filaments alternate, widening at the base. There are thirty-five species.

ORNITHOLOGY, that branch of natural history which considers and describes birds, their natures and kinds, their form, external and internal, and teaches their economy and uses; see AVES: also the several orders and genera in the alphabetical order. Birds are divided, according to the form of their bills, into six orders, *viz.* Accipitres, as eagles, vultures, and hawks: Picæ, as crows, jackdaws, humming-birds, and parrots: Anseres, as ducks, geese swans, gulls: Grallæ, as herons, woodcocks, and ostriches: Gallinæ, as peacocks, pheasants, turkies, and common fowls: and Passeres, comprehending sparrows, larks, swallows, &c.

Birds are distinguished from quadrupeds, by their laying eggs: they are generally feathered; some few are hairy, and instead of hands or fore-legs, they have wings. Their eggs are covered by a calcareous shell, and they consist of a white, or albumen, which first nourishes the chick during incubation; and a yolk, which is so suspended within it as to preserve the side on which the little rudiment of the chicken is situated continually uppermost, and next to the mother that is sitting upon it. The yolk is in great measure received into the abdomen of the chicken, a little before the time of its being hatched, and serves for its support, like the milk of a quadruped, and like the cotyledons of young plants, until the system is become sufficiently strong for extracting its own food out of the ordinary nutriment of the species.

ORNITHOPUS, in botany, *bird's foot*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: legume jointed, round, bowed. There are five species.

ORNITHORHYNCHUS *paradoxus*, in natural history, a singular quadruped, remarkable for its structure. The head is similar to that of a duck, which would lead to the supposition that it belonged to an aquatic bird. Both jaws are as broad and low as those in a duck, and the calvaria has no traces of a suture as is generally the case in full-grown birds. In the cavity of the skull there is a considerably bony falx,

which is situated along the middle of the os frontis, and the ossa bregmatis. The mandible of this animal consists of a beak, the under part of which has its margin indented as in ducks, and of the proper instrument for chewing that is situated behind, within the cheeks. Dr. Shaw says it has no teeth, though Mr. Home found, in a specimen examined by him, two small and flat molar teeth on each side of the jaws. The forepart of this mandible, or beak, is covered and bordered with a coriaceous skin, in which three parts are to be distinguished, *viz.* the proper integument of the beak; the labiated margins of it; and a curious edge of the skin of the beak. Into these three parts of that membrane numerous nerves are distributed, intended, probably, as the organs of feeling, a sense which, besides men, few mammalia enjoy; that is, few animals possess the faculty of distinguishing the form of external objects, and their qualities, by organs destined for that purpose, a property very different from the common feeling by which every animal is able to perceive the temperature and presence of sensible objects, but without being informed by the touch of them, of their peculiar qualities. Thus the skin in the wings of the bat, and its ear, are supposed the organs of common feeling, by means of which they are enabled to flutter, after being blinded, without flying against any thing. The whiskers of many animals appear likewise to serve the same purpose of informing them of the presence of sensible bodies, and hence they have been compared to the antennæ of insects. But to return to the ornithorhynchus: it is an animal which, from the similarity of its abode, and the manner of searching for food, agrees much with the duck, on which account it has been provided with an organ for touching, *viz.* with the integument of the beak richly endowed with nerves. This instance of analogy in the structure of a singular organ of sense in two species of animals, from classes quite different, is a most curious circumstance in comparative physiology, and hence the ornithorhynchus is looked upon as one of the most remarkable phenomena of zoology.

OROBANCHE, in botany, *broom-rape*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx bifid; corolla ringent; capsule one-celled, two-valved, many-seeded; gland under the base of the germ. There are fourteen species.

OROBUS, in botany, *bitter vetch*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx blunt at the base; the upper teeth deeper and shorter; style linear. There are sixteen species.

ORONTIUM, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: spadix cylindrical, covered with florets; corolla six-petalled, naked; style none; follicles one-seeded. There are two species, *viz.* O. aquaticum, and O. japonicum.

ORPHAN. In the city of London there is a court of record established for the care and government of orphans.

ORPIMENT is a fine yellow powder, formed from a solution of the white oxide of arsenic in muriatic acid, to which is added a solution of sulphuretted hydrogen in water. It may also be obtained by subliming arsenic and sulphur by a heat not sufficient to melt them. It is likewise found native in many parts of Germany and Italy, composed of plates that have a considerable degree of flexibility. Its specific gravity is 5.3. It is used as a pigment. The Chinese fashion vessels of different shapes, and their pagodas, of the mineral.

ORRERY, a curious machine for representing the motions and appearances of the heavenly bodies. See PLANETARIUM.

ORTEGIA, in botany, so named in honour of Joseph Ortega; a genus of the Triandria Monogynia class and order. Natural order of Caryophylleæ. Essential character: calyx five-leaved; corolla none; capsule one-celled; seeds very many. There are two species, *viz.* O. Hispanica, Spanish ortegia, and O. dichotoma, forked ortegia, natives of Spain and Italy.

ORTHOGRAPHIC *projection of the sphere*, that wherein the eye is supposed at an infinite distance; so called because the perpendiculars from any point of the sphere will all fall in the common intersection of the sphere with the plane of the projection.

ORTHOGRAPHY, that part of grammar which teaches the nature and affections of letters, and the just method of spelling or writing words with all the proper and necessary letters, making one of the four greatest divisions or branches of grammar.

ORTHOGRAPHY, in geometry, the art of drawing or delineating the fore right plan of any object, and of expressing the heights or elevations of each part. It is called or-

thography, from its determining things by perpendicular lines falling on the geometrical plane.

Orthography, in architecture, the elevation of a building. This orthography is either external or internal. The external orthography is taken for the delineation of an external face or front of a building; or, as it is by others defined, the model, platform, and delineation of the front of a house, that is contrived, and to be built, by the rules of geometry, according to which pattern the whole fabric is erected and finished. This delineation or platform exhibits the principal wall with its apertures, roof, ornaments, and every thing visible to an eye placed before the building. Internal orthography, which is also called a section, is a delineation or draught of a building, such as it would appear were the external wall removed.

Orthography, in perspective, is the fore-right side of any plane, *i. e.* the side or plane that lies parallel to a straight line, that may be imagined to pass through the outward convex points of the eyes, continued to a convenient length.

Orthography, in fortification, is the profile or representation of a work; or a draught so conducted, as that the length, breadth, height, and thickness of the several parts are expressed, such as they would appear if perpendicularly cut from top to bottom.

ORYCTOLOGY is the science which teaches the natural history of those animal and vegetable substances which are dug out of the earth, in a mineralized state. In the following slight sketch of the history of these substances it will be seen, that the remarkable situations in which they have been found, and the extraordinary changes which they have undergone, have led to the adoption of various contradictory and absurd notions respecting their nature and origin; which have been corrected, as just ideas have been obtained respecting the formation of the earth itself. Xenophanes, more than 400 years before Christ, was led to the belief of the eternity of the universe, by discovering the remains of different marine animals imbedded in rocks, and under the surface of the earth. Herodotus ascertained the existence of fossil shells in the mountains of Egypt, and was thereby induced to conclude, that the sea must have once covered those parts. In the pyramids of Egypt, mentioned by this author, and which had been built at so early a period that no satisfactory accounts could be derived from tradition respecting their erection, the stones were found to contain the remains of marine animals, and particularly of such as exist no longer in a recent state, and differ essentially from all known animals. These were supposed by Strabo, who saw the fragments of these stones laying around the pyramids, to be the petrified remains of the lentils which had been used for food by the workmen. Eratosthenes, Xanthus of Lydia, and Strabo, have all noticed and variously commented upon the existence of animal remains thus wonderfully preserved. In the works of Pliny many fossil bodies are mentioned; particularly the bucardia, resembling an ox's heart, but which was doubtlessly a cast formed in a bivalve shell; glossopetra, bearing the form of a tongue, and supposed to fall from the moon, when in its wane; hammites, resembling the spawn of fish; horns of ammon, resembling, in form, the ram's-horn; lepidotes, like the scales of fishes; mèconites, bearing a resemblance to the seeds of poppies; brontia, to the head of a tortoise; spongites, to sponge; phycites, to sea-weeds or rushes, &c. Although many were convinced, by the exact resemblance which several of these substances bore to different species of marine animals, that these must be the remains of such animals, and must have been deposited on these spots, at a period when they were covered by the sea; others, unable to comprehend a circumstance so inexplicable as the existence of the sea over some of the highest mountains, chose rather to have recourse to an apparently more easy mode of explanation, by attributing their formation to the energies of certain occult powers, such as the *vis plastica*, *vis formativa*, and *vis lapidificativa*.

The formation of these bodies was also attributed, by our countryman, Dr. Plot, to certain plastic powers inherent in some saline bodies; and Dr. Woodward, one of our latest writers on these substances, although aware that the situations in which these bodies were found, could only be explained by the powerful and extensive effects of the deluge, found himself obliged also to have recourse to an occult plastic power, to explain the formation of some of these substances. "There are," he observes, "various phenomena, that plainly shew that when they were brought forth at the deluge, the earth was destroyed, all the solids of it, metals, minerals, stone, and the rest, dissolved, taken up into the water, and there sustained along with the sea-shells, and other extraneous bodies; till at length

all settled down again, and formed the strata of the present earth. The shells, and other extraneous bodies, being thus lodged among this stony and other mineral matters, that afterwards became solid: when this comes now to be broke up, it exhibits impressions of the shells, and other bodies lodged in it; showing even the hardest of it to have been once in a state of solution, soft, and susceptible of impression." (Preface to Catalogue of English Fossils, p. 3.) But unable otherwise to oppose the opinion of Dr. Buttner, that the fossil corals were actually corals which had existed before the flood, he had recourse to the supposition of their having derived their forms from a second arrangement of their component parts, whilst in the waters of the deluge. "I have seen," he says, "fossil coralloids that have been composed of various sorts of mineral and metallic matter, that yet have been formed into shape of the marine mycetitæ, astroitæ, and other like corals. Now all these have been formed out of the dissolved mineral and metallic matter in the water of the deluge. The antediluvian corals were like all other solid stony bodies then in solution in that water, and might concrete again and form true corals there as well as in the sea water. Doubtless it did so; but that matter was in so small a quantity, and bore so little a proportion to the mineral and metallic, with which it was then mixed and confused, as now rarely, if ever, to be met with." (Letters on Fossils, by Dr. Woodward, p. 82.) At present, no one hesitates at considering all organized fossil bodies as having existed during a former state of this globe, and having been then endued with the energies of vegetable or animal life.

Various appellations have been employed for the purpose of distinguishing these bodies from those minerals which do not owe their forms to animal or vegetable organization.

Figured stones *(lapides figurati et idiomorphi)* and diluvian stones *(lapides diluviani)* were terms well chosen by the earlier mineralogists to designate these bodies, of the peculiar forms of which, and of their having probably obtained those forms from some changes depending on the deluge, they only could, with any propriety, speak. The term fossil comprising every mineral substance dug out of the earth, it was thought necessary to distinguish these by the term adventitious or extraneous. To this generally adopted mode of distinction, Mr. Parkinson (Organic Remains, vol. i. p. 34,) objects.

The term extraneous, he observes, denotes that the substance spoken of is foreign to the region in which it is found; a sense in which, he thinks, it cannot, with propriety, be applied to such bodies as are almost deprived, not only of their primitive form, but of their original constituent principles. In these cases, where so considerable a degree of naturalization, as it were, has taken place, the substance, he conceives, can no longer merit an epithet implying their being foreign to the regions in which they are found. Instances of the impropriety of this employment of the term he instances in such of the jaspers and semiopals as have derived their origin from wood; to which the epithet of extraneous does not appear to be strictly applicable. The term adventitious, as implying the result of chance or accident, he thinks ought never to be applied to these substances; since, in all nature's works, there exist not stronger proofs of the provident design of the Almighty Creator, than in the apparently casual disposition of these substances. To the term petrifaction he objects, because a conversion into stone only is here expressed; whereas, in many instances, the substances of which the fossil is composed differs as much from stone, as from the matter of which the body was originally composed. Fossils he considers as of two kinds, primary and secondary; among the former he places those bodies which appear to have been, *ab initio*, the natives of the subterranean regions; and under the latter he disposes those substances, which, though now subjects of the mineral kingdom, bear indubitable marks of having been originally either of an animal or vegetable nature. The term fossil, however, which implies that the organized substance under examination has been dug out of the earth, appears to be sufficient, without any adjunct to express these substances; indeed this term is warranted to be thus employed by its general acceptation.

Besides those bodies which, being actually organic remains, deserve to be considered as fossils, *(fossilia, vulgo dicta* of Linnæus); other bodies require to be noticed, as sometimes serving to illustrate the nature of organised fossils. These are, impressions, *(impressa*, Linnæus; *typolithi*, Waller); Casts, *(redintegrata*, Linnæus); and incrustations, *(incrustata*, Linnæus.)

Fossils naturally divide into vegetable and animal, according to which of those kingdoms they originally belonged; those

of the vegetable kingdom shall be the first subjects of our inquiry.

The parts of vegetables confined in subterranean situations suffer, according to circumstances, either a complete resolution of composition, the lighter parts becoming volatilized, whilst the more fixed remain and form the substance which is termed mould (*humus*); or, as is supposed by Mr. Parkinson, it passes through another process, which he considers as fermentative, and becomes bituminous. Wood, thus changed, is called lignum fossile bituminosum, surturbrand, and Bovey coal. By the extension of this process, the same author supposed, that the substances termed bitumens, (naphtha, petroleum, and asphaltum), are formed. To the same process he also attributes the formation of amber, of which however no proof appears. That jet, cannel coal, and the common coal employed in domestic uses, have had a vegetable origin, is rendered highly probable, from the frequency with which they manifest the impressions of various vegetable bodies.

Thus, perhaps, the formation of the bituminous fossils may be satisfactorily explained; but by far the greater number of vegetable fossils, are of a lapideous nature, and necessarily owe their formation to very different processes; which the same author supposes are, in general, preceded by the process by which bitumen is formed. Many bodies which are evidently of vegetable origin may be now found existing in a lapideous, either calcareous or silicious, state; and many others are found possessing certain marks of the presence of some metallic substance.

To explain these formations, various opinions have been formed. Some have supposed the injection of the impregnating matter, in a state of fluidity, by ignition; whilst others have imagined the gradual abstraction of the original particles of the body, and the regular deposition of the impregnating particles in the spaces which have just been left by the original matter. Mr. Parkinson, who does not admit of this substitution, attributes the formation of this description of fossils to the impregnation of vegetable substances, which have undergone different degrees of bituminization, with water, holding the earths or the metals in solution. Thus with lime is formed the calcareous wood or wood-marble of Oxfordshire and Dorsetshire, of Piedmont and of Bohemia; with silex is formed the calcedonified, agatified, and jasperified wood (Holstein); and with the addition of alumine, &c. the fossil woods which now partake of the nature of pitch-stone, and wax-opal (Holzopal). In other situations, metallic impregnations occur; as in such woods as are impregnated with the pyrites of iron, so frequently found in our islands; and the beautiful woods of Siberia, containing the hydrate and carbonate of copper.

Various parts of trees and plants (phytolithi) are found in a mineralized state. Not only fossil wood (lithoxylon), as has been just noticed, but the leaves (lithopylla or lithobiblia), and fruits (carpolithi) of different trees or plants are thus found. Of the woods, several, from their form and texture, have been supposed to have been originally oak, willow, and such trees as now exist in a recent state; whilst others differ, in both these respects, from any species of wood which is now known.

The impressions of the stalks and leaves of plants are very frequently found in many parts of the world, in lofty mountains, as well as at a considerable depth below the surface; and not only the impressions, but the substance itself of different vegetables are also thus found; but in no situation more frequent than in the neighbourhood of coal mines.

In general these vegetable remains are found deposited in lamina, in the schistose strata which accompany the coal; but the most perfect remains are commonly found in roundish nodular masses of ferruginous clay, which abound in the strata accompanying the coal. These are commonly termed catheads by the workers of the coal mines, and contain pieces of fern, &c. very few, indeed, of which are found to agree with any known recent plants. One of these plants, preserved in coal slate, is shewn, Plate I. ORYCTOLOGY, fig. 1. The vegetable remains in these fossils appear to confirm the opinion above mentioned, of the bituminization of fossil vegetables; since these leaves are completely changed into a bituminous substance.

The remains of fruits are, perhaps, no where found so abundantly as in the Isle of Sheppey, where they are dug up in great variety; very few, however, being found which agree with any known recent fruits. Where any resemblance appears, it is with fruits which only grow in the warm Asiatic regions. Plate I. fig. 2, represents a fossil fruit which was found in the cliff of Sheppey.

Fossil roots of plants of trees are very rarely found; a circumstance not very easily

explained; since they possess (especially the roots of trees) that degree of solidity which appears to be favourable to the process of petrifaction. From the want of this necessary property it undoubtedly is, that we possess so few remains of tender flower leaves, and none of pulpy fruits.

From the same cause, the great proneness to decomposition, the number of animal fossils is considerably limited: those substances being only preserved in a mineralized state which originally possessed a considerable degree of solidity; such are the bones, teeth, horns, shells, scales, &c. The animal, however, far exceeds the vegetable kingdom in the number and variety of fossils which it yields, as well as in the distinctness of form, and excellency of preservation, in which they are found.

Adopting in a great measure the arrangement of Waller, we shall commence our examination of the animal fossils with those which have derived their origin from corals. These fossils are, of course, merely the remains of the dwellings which have been formed by the various coral insects, and which are so frequently found in the cabinets of the curious.

Immediately on commencing this examination, we are struck with a similar want of agreement between the recent and fossil corals, with that which has been noticed between recent and fossil vegetables. Of the genus Tubipora it does not appear, at least by the observations made in Mr. Parkinson's second volume of "The Organic Remains of a former World," that a single species which is known recent has been found as a fossil. Several fossil species are, however, described, of which nothing similar is known in a recent state. The most striking of these is the Tubipora catenularia, or chain coral, the surface of which, in consequence of the tubes being in contact at their sides, has frequently a very curious reticulated of catenulated appearance. Plate I. fig. 4, represents this fossil in its usual state: and at fig. 5 is shewn the appearance yielded by a transverse section. Tubipora fascicularis, T. stellata, T. repens, and T. strues, which have been described by different authors, and which are unlike to any known recent Tubipore, give reason for supposing that the number of species of fossil Tubipores exceeds that of the recent species.

The fossil Madrepores are not less rich in variety, nor less comparatively numerous, than the fossils of the preceding genus. The forms of several species of the fossil Madrepores do frequently approach to those of the different recent species; but in a considerable number of the fossil Madrepores no resemblance is discoverable, except in their stelliform openings, with any recent coral. So great indeed is this departure in some instances from the general characters of our present known Madrepores, that it has been deemed difficult to determine, whether some fossil specimens should be considered as Madrepores or as Alcyonia. It is impossible, without the aid of numerous figures, to give satisfactory notions of the forms of the several fossil Madrepores which have been hitherto discovered; the most interesting only will therefore be here particularized.

The Madrepores consisting of a single star appear to be much more numerous in a mineral than in a recent state. These are either of a discoidal form, having a concave superior and a convex inferior surface; of a pyramidal top-like form, terminating in a pedicle; or of a lengthened pyramidal form, bearing in some, from a slight curvature, the appearance of the horn of an animal; whilst others are cylindrical for a considerable part of their length.

The first of these, Madrepora porpita, the shirt-button Madrepore, has been long known to the collectors of fossils in this kingdom. Dr. Woodward describes several of them, as mycetitæ discoides. The second species (Madrepora turbinata) is also frequently found in different parts of Great Britain, as well as in Sweden, Norway, and in several parts of France, Switzerland, and Italy. These latter fossils have been termed by Dr. Woodward mycetitæ conoides seu calyciformes. When they have acquired somewhat of a hornlike shape, they have been distinguished by the term ceratites; and when they have possessed more of the cylindrical form, they have been termed columelli lapidei et hippuritæ; and from a supposed resemblance, they have been also considered as the petrified roots of briony. Some of the single starred corals are found united at their pedicle, and approaching towards each other at their summits, though disjoined nearly through their whole length. These, from their resemblance to petrified reeds, have been named junci lapidei.

It would be useless to attempt, in this sketch, to specify the considerable variety of fossil Madrepores formed of aggregated circular stars, and which have been designated as astroites, &c. Those which are composed of angulated stars are, perhaps, not so numerous: many of these, however,

are very different in their appearance from those which are known in a recent state. The one most known in these islands is the lithostrotion, sive basaltes striatus et stellatus, of Llwyd. The exact union of the sides of the polygons giving a tolerably correct idea of minute basaltes. The compound Madrepores, the stelliform part of which are extended in undulating labyrinthean forms, appear to be much less numerous as fossils than any of the other corals: their existence in a silicious state very rarely occurs.

The Milleporæ do not appear to be nearly so frequently found in a mineral as in a recent state. Several fossils have been placed among the Millepores which undoubtedly should rank with the Madrepores: such are the Millepora simplex turbinata, and the Millepora simplex discoides, of Waller and Gesner; a careful examination shewing, that these differ from the porpital and turbinated Madrepores, only in their being formed of numerous tubes, possessing an internal stellated structure.

Of the genus Isis one species only appears to be known as a fossil. This species was first described by Scilla, who at first conjectured it to be the leg-bone of some animal. Specimens are frequently found in the Calabrian mountains, and have lately been also found in some parts of Wiltshire. Of the genus Cellepora, Antipathes, and Gorgonia, fossil specimens appear to be rather uncommon.

The Corallo Fungitæ of Waller are evidently the fossil remains of Alcyonia. These have been long described by Volkmann, Scheuchzer, and others, as fossil fruits, and have obtained, from their resemblance to figs, &c. the appellations of ficoides, caricoides, &c.; whilst others of a different form have been named lycoperditæ, fungitæ pilcati, &c. A fossil Alcyonium has even been described by Volkmann and Scheuchzer as a fossil nutmeg. A fossil Alcyonium of a conical form is represented Plate I. fig. 6.

The Encrini and Pentacrini have been always, and very properly, considered as the most curious of the fossil Zoophytes. The Encrinus (Plate I. fig. 3) possesses the distinguishing character of having its spine, or, as it has been generally called, its tail, composed of cylindrical or orbicular vertebræ, pierced through their centre, and marked with diverging striæ on their articulating surfaces. On the superior termination of these is placed the base of the body of the animal, formed of five trapezoidal bodies, termed by Rosinus articuli trapezoides, which inclose five small bodies, which form the centre of the base; the whole of these forming that which Rosinus denominated the pentagonal base. From each of these proceed six other bodies, on the two last of each series of which are placed the arms of the animal, which divide into fingers; from the internal surface of these proceed almost innumerable articulated tentacula. This fossil has long possessed the name of the Encrinus, or stone lily; its resemblance to that flower having led to the suspicion that it was a petrifaction of a flower, approximating in its form to the lily: its animal origin is however now completely ascertained. Indeed, if a doubt had remained, it would have been removed by the circumstance of the animal membrane, or cartilage, having been actually discovered in the fossil, ("Organic Remains of a former World," vol. ii. p. 166.) Several other species of this animal are also described in the work just referred to; but hitherto no recent animal has been found which can be referred to this genus.

The fossil Pentacrinus differs from the Encrinus, in its vertebræ being of a pentagonal form, and in its arms, fingers, and tentacula being capable of being much more widely spread and extended than are those of the Encrinus. It appears from Mr. Parkinson's account, that there are several species of this fossil, the existence of some recent species of which have been also ascertained.

The encrinital vertebræ (Plate I. fig. 7 a) have been hitherto termed trochitæ when separate, and entrochi when connected in a series, (Plate I. fig. 7.) The single vertebræ of the Pentacrinus have been distinguished as asteriæ, (Plate I. fig. 8 a); and when united together they have been termed columnar asteriæ, (Plate I. fig. 8.)

Of the Asteriæ, or Stellæ Marinæ, some very few specimens have been found fossil; but they occur very rarely, and have, in general, been found in a condition too imperfect to allow of any positive opinion being formed, respecting the species to which they belong.

The fossil Echini are very numerous, upwards of forty species, known only as fossils, being enumerated by the illustrious Linnæus; to delineate, therefore, even those most deserving of notice could not be here well accomplished; a circumstance, however, which is not so much to be regretted,

since, though materially different, they approach very nearly in their general form to the recent species. Those which possess a hemispherical, or a nearly orbicular form, with large mamilla-like protuberances, and the anus disposed vertically, have been distinguished as the turban echini (*echini cidares*); those which resemble a shield or buckler in their figure are termed the shield echini (*clypei Kleinii*); and one of the largest of these has been named the polar stone by Dr. Plot (Plot's Oxfordshire, p. 91.) When of a depressed circular form, with the anus in the edge of the inferior part, they are the fibulæ of Klein; of a conical form, the eaglestone of the Germans (*conuli, Kleinii*); with a circular base, the quoit echinus (*discoidei, Kleinii*). When the base is an acute oval, the mouth and anus being at the opposite ends, they are termed the helmet echinis, (*cassides et galeæ, Kleinii*); and when heart-shaped, with a sulcated superior surface, they are called snake's hearts (*spatangi, Kleinii*.)

The attempt to particularize the various species of fossil shells which have been found would require a large volume: all that can be here done is to notice some of those which totally differ from any which exist in a recent state, and to offer some few remarks on those which approximate, or are perhaps similar to some of the species which are known in a recent state.

With respect to the state in which fossil shells are found, it is necessary to remark, that, in some situations, shells which have been buried for ages, by the natural changes which the surface of the earth has undergone, are found very little changed, except from the loss of colour, and having been rendered extremely fragile; that in other situations the substance of the shell has been so injured, as to be reduced to very small fragments, and even to a fine powder, leaving in some instances a stony, correctly moulded, cast of the cavity of the shell; that very frequently the substance of the shell is entirely altered, having become a calcareous stone, or a silicious or pyritous mass, and that the shells of a former world are frequently found in masses of marble, which is called lumachelli, or shelly marble.

Of the Multivalves, the chiton does not appear to have been found in a mineralized state; and although several species of Lepas have been found in a mineral state, they are by no means frequent fossils. Lepas anserifera is said to have been found fossil, as well as Lepas diadema; these must, however, be exceedingly rare fossils.

Fossil shells of the Pholas are by no means common; the Pholas crispata has been however, found among the Harwich fossils.

Fossil bivalves are very common fossils; they are, as might be expected, very seldom found in pairs, except when united by a lapideous mass, which prevents the examination of their hinge, or their internal structure, which in many fossil shells, are objects highly worthy of examination.

The Mya pictorum is described by Solander as existing among our Hampshire fossils: a fossil mya of three or four inches in length, is found also in the rocks near Bognor. Remains of the solen siliqua, and of the solen ensis, have been found at Harwich, and a small fossil shell, named by Solander solen ficus, has been found between Lymington and Christchurch.

Fossil shells of the genus Tellina, as well as of cardium, mactra, donax, venus, spondylus, chama, arca, and particularly ostrea, have been found of many species But no bivalve exists as a fossil in such prodigious numbers, and in such various species, as those of the genus Anomia. These shells are characterized by the beak of the largest or under valve, which is perforated, being greatly produced, rising or curving over the beak of the smaller or upper valve. Anomia lacunosa (Plate II. fig. 1.) is one of the most abundant of these species. They are found in considerable quantities in different parts of England, particularly in Lincolnshire, Warwickshire, and Gloucestershire. Anomia terebratula, (Plate II. fig. 2), is another fossil of this genus, which exists in different counties in this island, in great abundance.

Of the genus Mytilus several species are known as fossils, some of which approach very near to those which are known recent: one in particular appears to differ very little indeed from Mytilus modiolus. Fossil shells of the genus Pinna, in any tolerable state of preservation, are not frequently found: the shells are in general so fragile as to render it very difficult to obtain them tolerably perfect; or so that but little information can be yielded respecting the species to which they belong.

No fossil shell appears yet to have been found which can with certainty be placed under the genus Argonauta. But of the genus Nautilus, specimens are very frequent. These have been found in several parts of

this island: some very fine specimens have been found at Lime in Dorsetshire, in different parts of Wiltshire, and at Whitby in Yorkshire. The finest specimens are perhaps found in the neighbourhood of Bath, and in the Isle of Sheppey in Kent, at which latter place they are found exceedingly large, and still retaining a resplendent pearly shell. (Plate II. fig. 3.)

The Cornu Ammonis, which, if we except the extremely minute shells of this kind which have been seen by Plancus, and others, in the sea sand on the Venetian shores, may be said to be only known to us in a fossil state.

Like the Nautilus, the Cornu Ammonis is divided into compartments, by regularly disposed partitions, and these partitions are perforated, as are those of the Nautilus, although it is by no means easy to point this out, except in very few specimens.

There are none of the fossil shells, except perhaps the Anomiæ, which can vie in the variety of their species with the Cornu Ammonis. The shell of some is perfectly smooth over its whole surface; in others smooth at the sides, but ridged or beset with spines at the back; and others, though smooth at the side, are crenulated at the back. The species most commonly met with have the shell variously ridged; some with small close striæ, and others with large and round ridges. In some the ridges are single, in others bifurcated, and in others trifurcated. In some, and these are least common, the shell is tuberculated: these tuberculæ differing considerably in different species, in their size, form, and disposition. The different species proceeding from the intermixture of all these varieties, it must be obvious, must be exceedingly numerous: Schenchzer was able to determine the existence of one hundred and forty-nine species. The difference of size observable in these fossils is not less remarkable than the variety of their forms, some being found not much larger than the head of a pin, whilst others have been found as large as the top of a small table.

A peculiar appearance is observable on the surface of many of these fossils, which depends on the peculiar form of the septa which separate the chambers of the shell. These septa in the nautili are smooth, and terminate at the surface of the shell in a straight line; but in the Cornua Ammonis they become undulated as they extend outwardly; and in some so much so as to form, on the outer surface, deeply crenulated lines, giving the appearance of foliaceous sutures. When the cavities of the shell have become filled with stone, and the septa just mentioned have been removed, as is frequently the case, by some chemical agent, the casts formed in the chambers separate, each forming a curiously figured stone; these separate casts have been termed spondylolites. (Plate II. fig. 4.) By the junction of these are formed the foliaceous sutures above mentioned. The Cornua Ammonia were formerly called serpent-stones; the appearance which they yield of a serpent coiled having led the vulgar to consider them as petrified serpents.

The fossil Cones are very few when compared with the numerous species known in a recent state; the same may be also said of the Cypræ. In both these genera the species are mostly made out more from the colour and the markings of the shells, than from the peculiarities of their form; but in the fossil shells the colours no longer exist, and of course the species in these can very seldom be presumed. The fossil Volutes, as far as can be judged from their form alone, differ generally from the recent species. With respect to the genus Buccinum, Strombus, and Murex, the number of species of the fossil shells do not appear to equal those which are known in a recent state. This is the case also, in a still greater degree, with the genus Trochus. The fossil shells of the genus Turbo are pretty numerous, and some of them very closely resemble those of known recent species. One fossil shell of this genus is very remarkable for its vast size, being upwards of a foot in length. The cast of another species is so large as to weigh four or five pounds. Nothing like this occurs with respect to the species of the genus Helix: the fossil shells of this genus very much resemble those which are recent, and are not found of any considerable magnitude. The fossil shells of the genus Nerita by no means display so many species as the recent; but some of the fossil species far exceed the recent in size, and one in particular is twelve times the size of any known recent species. Of the genus Haliotis, it is not positively determined that a single shell has been seen, which could be considered as fossil. Fossil shells of the genus Patelta are by no means common. Several species have, however, been found in France, in a state of excellent preservation. Some few also have been found in the cliffs at Harwich, and others, of a different species,

imbedded in the lime-stone of Gloucestershire. Dentalia, apparently similar to existing species, have been found in Hampshire, and in some parts of France and Italy, exceedingly well preserved. In Italy also have been found specimens of Serpulæ, very similar to those which are known recent; but others have been found in France exceedingly different from any known recent species.

The Orthoceratites, a lapidified conical or cylindrical chambered shell, the septa dividing the chambers of which are perforated like those of the Nautilus, is a genus of which not a species is known in a recent state, excepting the microscopic specimens found by Plancus in the sand of the Riminian shore. Much is wanting to complete the history of this fossil, since from the state in which the specimens have in general been found, very few, or perhaps none, have been obtained perfect. Authors have divided them into those which are straight (Plate II. fig. 8.), and those which have a spiral termination, the latter of which are considered as fossil shells of the Nautilus lituus; but the extraordinary disparity of size is sufficient to shew that they can hardly be considered of the same species, the recent shell being seldom more than an inch in length, whilst the fossil is described as being sometimes the size of a man's arm.

The Belemnite (Plate II. fig. 7.) is a spathose radiated stone, generally conical, but sometimes possessing a fusiform figure, and contains, in an appropriate cavity at its larger end, a smaller calcareous body (*alveolus*) which has evidently been a concamerated shell, the septæ of which are pierced like those of the preceding fossil. These fossils are from an eighth of an inch to two inches in thickness, and from an inch to a foot and a half in length. They are sometimes found imbedded in chalk or limestone, and sometimes in pieces of flint; but they are most frequently detached from their matrix. Various have been the opinions respecting this fossil; some have considered it as the horn of a narwhal, and others as a concretion formed in the pennicilla marina, or in some shell of the dentalium kind. Some have even supposed it to be of vegetable origin, whilst others have considered it as entirely belonging to the mineral kingdom. But that the Belemnite originally existed in the sea, is evident from its being commonly found with the remains of the undoubted inhabitants of the ocean, and that it is of an animal nature, is rendered evident by its structure. Among the concamerated fossil shells may be placed the Helicites, or nummular, or lenticular stones. These are round flattish bodies; but in general of a lenticular form, both sides possessing a slight degree of convexity. On each side are sometimes seen traces of its internal structure and of its spiral formation; whilst sometimes these appearances appear to be concealed by a thicker covering. Various opinions have been entertained respecting their origin, but no doubt can exist of their having existed in the ancient ocean as a spiral chambered shell, and of their being one of those species of animals which are now lost.

Among the fossil shells which can only be here enumerated, are the rare tuberculated turrilite, or chambered turbinated shell, the orbulites, planulites, and baculites of Lamarck.

Insects of the smaller kinds are seldom found in a fossil state, the smallness of their size and the delicacy of their structure most probably preventing their preservation. Those which are in a state to allow any thing of their general form to be made out are consequently very few. The one which is generally found in the most perfect condition, is that which is generally known to us as the Dudley fossil, from its being found in the neighbourhood of Dudley, in Worcestershire. (Plate II. fig. 5.) Other species of this animal have been found in Wales, and in different parts of Germany. From the imperfect state in which these insects are found, little more, perhaps, can be said of them, except that the remains which have been examined shew that the covering of their body was formed by three series of thick crustaceous plates, transversely disposed in rows, the length of the body; whilst one plate served to give a covering to the head of the animal. Other remains of the smaller insects have been mentioned by different authors; but few or none appear to have been described as agreeing with any insect now known to be in existence.

The remains of lobsters, and crabs, are frequently found in the isle of Sheppey, and Malta. The remains of different species of these animals are also found in a compressed state in the margaceous and schistous masses of Pappenheim and Oppenheim.

The fossil remains of amphibia are very numerous, and supply us with ample exercise for inquiry and admiration. In different parts of England, particularly in

Somersetshire and Dorsetshire, the remains of animals apparently of the Lacerta genus are frequently found; but are, as far as we are able to judge, really different from any animal which is known to us. But in no part of the world have such exquisitely fine and wonderful remains of animals of this description been found as in St. Peter's mountain near Maestricht. A most beautiful specimen of part of the jaw of the fossil animal of St. Peter's mountain was presented to the Royal Society, by professor Camper, and is now very properly exhibited in the British Museum. A wonderful specimen of the head of this animal has been also obtained from the same mountain by Faujas St. Fond; and is delineated in the elegant work which he has given to the world, descriptive of the fossil riches of that mountain. "Histoire Naturelle de la Montagne de Saint-Pierre de Maestricht."

The plates of St. Fond, as well as the specimen of professor Camper, shew that these are the remains, indubitably, of an enormous animal, different from any at present known. It must however be observed that the remains of crocodiles, apparently of the same species which now exist, have also been discovered: part of the head of the Asiatic crocodile was found in very good preservation in the quarries of Altdorff.

Fossil fishes have been found imbedded in calcareous and argillaceous masses, in various parts of Germany, Switzerland, and Italy; but no where in such prodigious numbers as in the mountain named Vestena-Nuova, generally called Monte Bolca, in the Veronese: which extends, in height, a thousand feet above the quarry, in which are found the numerous remains of fish; of which, specimens are to be seen in almost every cabinet of repute in Europe.

The remains of fishes, from an inch to upwards of three feet in length, are found in these quarries, and of these several are found, whose living analogues are said to exist in the neighbourhood of Japan, and of Brasil, also in Africa and America. The Abbé Fortis is of opinion that the actual descendants of the Veronian fossil fishes are now to be found in the sea which washes the shores of Otaheite. In Cerigo, (Cytherea) Alessano, Lesina, in Dalmatia, Oeningen, Pappenheim, in Aix, and in several parts of France, fossil fishes are found in very excellent preservation. In England fossil fishes are much more rarely found than in France, Germany, or Italy.

The fossil fish of Vestena Nuova are supposed to prove, from several circumstances, that their privation of life was sudden; some having been found with the head of their prey still in their mouths; and others with the remains of the fish, which they had devoured, still in their stomachs.

The fossil remains of birds are very rarely found; although frequently mentioned and even described by different authors. Fossils very much resembling the beaks of birds are sometimes found; but these are much more probably parts of fishes. Several of those specimens which have been spoken more positively of, as petrifactions of whole birds, and of their nests, have been merely calcareous incrustations of very modern formation. Bones very much resembling the bones of birds have been found in the calcareous stone of Oxfordshire, and in some parts of France, and of Germany.

The fossil remains of quadrupeds, especially those of the larger kind, are such as must necessarily excite the attention and wonder of every curious inquirer in natural history. In various parts of this country have been found the remains of elephants, and of other animals of considerable magnitude. In Ireland have been found the remains of deer, of a size far exceeding any now known; and in Scotland have been found the remains of the elk, as well as those of an enormous animal of the ox kind, but larger than even the urus. In France, Germany, Italy, and indeed in most parts of Europe, remains of large animals have been found, and in both North and South America, the remains of enormous unknown animals have been discovered. According to Pallas, from the Tanais to the continental angle nearest to America, there is hardly a river in this immense space, especially in the plains, upon the shores or in the bed of which have not been found the bones of elephants and of other animals not of that climate. From the mountains by which Asia is bounded, to the frozen shores of the ocean, all Siberia is filled with prodigious bones; the best ivory (fossil) is found in the countries nearest to the arctic circle, as well as in the eastern countries, which are much colder than Europe, under the same latitude; countries where only the surface of the ground becomes thawed during summer.

The number of bones which have been discovered of the rhinoceros is very considerable, not only in Siberia, but in Germany,

and in other parts of Europe: and in the opinion of St. Fond, founded not only on the discoveries of Pallas and others, but on his own observations made on the immense collection of Merck, joined with that of the Landgrave of Hesse Darmstadt, are of the species with double horns. An entire body of an animal of this species, still possessing the skin, fat, and muscles, has been dug up near the river Willioni, in the eastern part of Siberia, from under a hill, which is covered with ice the greatest part of the year. St. Fond states, in confirmation of the above opinion, that another head obtained by Pallas from Siberia; one existing in the cabinet of the Elector of Manheim; and another in the cabinet of Merck, are all apparently similar to the head of the double horned rhinoceros of Africa.

This circumstance, so contradictory to the opinion he had formed, of these remains of large animals having been brought by floods from the eastern parts of the globe; and which opinion was confirmed by discovering that no remains of the African crocodile had been found in Europe; led him to further research, by which he found reason to suppose that, in fact, the rhinoceros, which corresponded with all the fossil remains, which he had seen, was the rhinoceros of Sumatra. By ascertaining this circumstance, the difficulty was removed, since Sumatra being separated from the peninsula of India merely by the Straits of Malacca, this animal might also have formerly existed there.

Much remains to be ascertained with respect to the fossil remains of elephants, of which considerable numbers have been found in various parts of England, France, Germany, and Italy; but no where so abundantly as in Siberia. In America indeed the remains of an unknown species of this animal are also very abundant. There appears to be only two species of elephants now in existence; one (the Asiatic) being distinguished by its grinders being divided into transverse and nearly parallel plates, and the other (the African) having these plates disposed in lozenge-like forms.

The elephantine remains which have been found in Siberia have been supposed to have belonged to no existing species; for though the teeth are formed of plates disposed parallel to each other, as in the Asiatic, these plates are said to be thinner, and consequently more numerous; but this distinction is by no means established. The remains of elephants discovered in this country seem referable, in most instances, to the Asiatic.

With respect to the elephant whose remains have been found in America, the tooth of which differs essentially from all known fossil or recent species, in having its crown cuspidated and covered with enamel, (Plate II. fig. 6) there exists at present every reason for supposing it to be of a species now extinct. The generally adopted opinion that this animal was of a carnivorous nature is by no means established; but is indeed contradicted by the assertion that the stomach of one of these animals has been found filled with vegetable matter. One of these animals, with its flesh, skin, and hair, has been lately found in Siberia.

The remains of an animal of an enormous size has been found at Paraguay, at no great distance from the river Plata, which being properly arranged has been formed into a skeleton and placed in the cabinet of natural history at Madrid. This animal, twelve feet in length and six in height, is distinguished, as well as by its general form, by the largeness of its claws; on which account, Mr. Jefferson, who has described some remains of a similar animal in the Philosophical Transactions of Philadelphia, has named it the megalonyx. The celebrated Cuvier has arranged this animal with the sloths; but Fanjas St. Fond, concluding that an animal so enormous was never intended to climb the trunks of trees, thinks he should not be thus classed; and wishes him to be held, as it were, in reserve, until some discoveries should supply us with more satisfactory notions respecting its nature.

In various parts of Scotland, and of France; in Tuscany, the Veronese, and in North America, have been found the fossil remains of some animal which has been supposed to be a variety of the urus of Julius Cæsar, or of the bison. But these horns, which are of very considerable size, the bone of each horn exceeding two feet in length, appear to have belonged to a different species of animal from any which is at present known. The observations which have been made on these fossils, particularly by the liberal and industrious Fanjas St. Fond, give great reason for believing that two species of animals have existed, bearing horns of this enormous magnitude. These remains are found to exist in Siberia along with the bones and horns

of the rhinoceros, and with bones and teeth of the mammonthean elephant of Siberia.

To the fossil remains already mentioned, may be added the animal incognitum of Symore, in Languedoc; the enormous stag, found in the mosses of Ireland; the gigantic tapir, found at the bottom of the black mountains of Languedoc; the bears, of two species, now unknown, found in Bareith; and the numerous animals of unknown species which the admirably indefatigable Cuvier is perpetually discovering, in that mine of fossils, the quarries of gypsum, near Paris.

Of the mineralized remains of man no well attested instance is known. In a cavern, indeed, in Mendip Hills, some human bones have been found, invested with stalactite; these appear to be but comparatively of modern existence. Scheuchzer published an essay describing a supposed skeleton of a man; which was undoubtedly the remains of some large fish.

A view of the foregoing sketch cannot but shew, that the study of this science must prove a source of the highest gratification to every mind that contemplates the works of nature, for the purpose of obtaining a glimpse of the beauty which they display, and of the power which they manifest. By this science we obtain, not only a knowledge of the peculiar beings which dwelt on this planet in its antediluvian state, but we also acquire a more correct knowledge of the structure of this globe itself. We at the same time discover the strongest proofs of those changes which it has suffered, and which are recorded in the Holy Scriptures; whilst our reverential admiration is excited at this wonderful display of the power and providence of the Almighty Creator.

ORYZA, in botany, *rice*, a genus of the Hexandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx glume two-valved, one-flowered; corolla two-valved, almost equal, growing to the seed. There is but one species, with many varieties. Rice has the culm from one to six feet in length, annual, erect, simple, round, jointed; leaves subulate, linear, reflex, embracing, not fleshy; flowers in a terminating panicle; calycine leaflets, lanceolate; valves of the corolla equal in length; the inner valve even, awnless; the outer twice as wide, four-grooved, hispid, awned; style single, two-parted. Rice is cultivated in great abundance all over India, where the country will admit of being flooded, and in the southern provinces of China, Cochin-china, Cambodia, Siam, and Japan; in the latter place it is particularly white, and of the best quality.

OSBECKIA, in botany, so named in honour of Peter Osbeck, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Melastomæ, Jussieu. Essential character: calyx four-cleft, with the lobes separated by a ciliary scale; corolla four-petalled; anthers beaked; capsule inferior, four-celled, surrounded by the truncated tube of the calyx. There are two species, *viz.* O. Chinensis, and O. Zeylanica.

OSCILLATION, in mechanics, the vibration, or reciprocal ascent and descent of a pendulum. See PENDULUM. It is demonstrated, that the time of a complete oscillation in a cycloid, is to the time in which a body would fall through the axis of that cycloid, as the circumference of a circle to its diameter; whence it follows: 1. That the oscillations in the cycloid are all performed in equal times, as being all in the same ratio to the time in which a body falls through the diameter of the generating circle. 2. As the middle part of the cycloid may be conceived to coincide with the generating circle, the time in a small arch of that circle will be nearly equal to the time in the cycloid: and hence the reason is evident, why the times in very little arches are equal. 3. The time of a complete oscillation in any little arch of a circle, is to the time in which a body would fall through half the radius; as the circumference of a circle to its diameter: that is, as 3.1416 to 1. If l denote the length of a pendulum, $g = 16\frac{1}{12} = 193$ inches, the space a heavy body falls through in the first second of time, and $p = 3.1416 =$ periphery of a circle whose diameter is 1, then, by the laws of falling bodies, it will be $\sqrt{g} : \sqrt{\frac{l}{2}} :: 1'' : \sqrt{\frac{l}{2g}} = \frac{4}{25}\sqrt{l} = \frac{16}{100}\sqrt{l}$ nearly the time of falling through $\frac{1}{2}l$: therefore $1 : p :: \sqrt{\frac{l}{2g}} : p\sqrt{\frac{l}{2g}}$, which is the time of one vibration in any arch of the cycloid which has the diameter of its generating circle equal to $\frac{l}{2}$, l being the length of the pendulum in inches; and since the latter time is half the time in which a body would fall through the whole diameter, or any chord; it follows, that the time of an oscillation in any little arch, is to the time in which a body

would fall through its chord, as the semicircle to the diameter. 4. The times of the oscillations in cycloids, or in small arches of circles, are in a sub-duplicate ratio of the lengths of the pendulums. 5. But if the bodies that oscillate be acted on by unequal accelerating forces, then the oscillation will be performed in times that are to one another in the ratio compounded of the direct sub-duplicate ratio of the lengths of the pendulums, and inverse sub-duplicate ratio of the accelerating forces. Hence it appears, that if oscillations of unequal pendulums are performed in the same time, the accelerating gravities of these pendulums must be as their lengths; and thus we conclude, that the force of gravity decreases as you go towards the equator, since we find, that the lengths of pendulums that vibrate seconds, are always less at a less distance from the equator. 6. The space described by a falling body in any given time, may be exactly known: for, finding by experiments, what pendulum oscillates in that time, the half of the pendulum will be to the space required, in the duplicate ratio of the diameter of a circle to the circumference.

OSIER, a very valuable shrub, of the Salix viminales, used principally in basket-making.

OSMITES, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, scariose; corolla of the ray ligulate; down obsolete; receptacle chaffy. There are four species, all shrubs, and natives of the Cape of Good Hope.

OSMIUM, one of the metals discovered by Mr. Tennant, in the black powder which remained after dissolving platina: the other metal was IRIDIUM, which see. The osmium was obtained by heating the black powder with pure alkali in a silver crucible. The oxide of this metal combines with the alkali, may be expelled by an acid, and, being very volatile, may be obtained by distillation. It does not redden vegetable blues, but stains the skin of a deep red or black. The oxide, in solution with water, has no colour; but by combining with alkali or lime, it becomes yellow. With the infusion of nut-galls, it gives a very vivid blue colour. It is precipitated by all the metals, excepting gold and platina. An amalgam may be formed with mercury, by agitating it with the aqueous solution of this oxide. When this amalgam is heated, the mercury is driven off, and the pure metal remains behind in the state of black powder. This metal was called osmium on account of the strong smell of the oxide.

OSMUNDA, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Generic character: capsules distinct, disposed in a raceme, in such a manner as to look the same way, or else heaped on the back of the pinna or division of the frond, sessile, sub-globular, opening transversely without any ring; seeds very many, extremely minute. There are twenty-seven species.

OSSIFICATION, the formation of bones, but more particularly the conversion of parts naturally soft, to the hardness and consistence of bones. All concretions which make their appearance in the solids of the animal body may be comprehended under this title with propriety, because they have a close resemblance to, and composed of similar constituents with BONE, which see. In the pineal gland concretions have been found, which consist of phosphate of lime. The same is true of concretions found in the salivary glands, in the prostate, and in the liver; and also in pulmonary concretions. The latter however are found to contain phosphate and carbonate of lime, and in some cases no phosphate, but

Carbonate of lime	82
Animal matter and water	18
	100

OSTEOLOGY, that branch of anatomy, which treats of the bones.

OSTEOSPERMUM, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx simple, or in two rows, many-leaved, almost equal; seeds globular, coloured, bony; down none; receptacle naked. There are seventeen species.

OSTRACION, the *trunk fish*, in natural history, a genus of fishes, of the order Cartilaginei. Generic character: teeth cylindric, pointing forwards and rather blunt; body mailed by a complete long covering. There are twelve species. We shall notice only the O. triqueter, or the triangular trunk fish, is about twelve inches long, and is completely, except to a very short distance from the tail, surrounded with a bony covering, divided into hexagonal

spaces, and overspread with a diaphanous epidermis, resembling thus the armadillo among quadrupeds. It is a native of the American and Indian seas, is thought a high delicacy in India, and lives, it is supposed, on worms and shell fish.

OSTREA, the *oyster*, in natural history, a genus of the Vermes Testacea class and order. Animal a tethys: shell bivalve, generally with unequal valves and slightly eared; hinge without teeth, but furnished with an ovate hollow, and mostly lateral transverse grooves. About 150 species have been enumerated, and classed into sections and subsections. A. furnished with ears and radiate; scallop. B. rough, and generally plated on the outside; oysters. C. hinge with a perpendicular grooved line. Most of this genus are furnished at the hinge internally with numerous parallel transverse grooves in each valve, and are immediately distinguished from the genus arca, in not having teeth alternately locking in each other. Scallops leap out of the water to the distance of half a yard, and opening the shells, eject the water within them; after which they sink under the water, and suddenly close the shells with a loud snap. O. maxima: shell with about fourteen rounded and longitudinally striate rays; is found in most European seas, in large beds, whence they are dredged up, and pickled and barrelled for sale. This, we are told, is the shell which was formerly worn by pilgrims on the hat or coat, as a mark that they had crossed the sea, for the purpose of paying their devotions at the Holy Land; in commemoration of which it is still preserved in the arms of many families. O. edulis: shell nearly orbicular and rugged, with undulate imbricate scales; one valve flat and very entire. Of this species there are many varieties. They inhabit European and Indian seas, affixed to rocks, or in large beds; the fish is well known as a palatable and nutricious food. The shell is of various sizes, forms, and colours; within white, and often glossy like mother of pearl; the old shells have often an anomia fixed to them, and are frequently covered with serpulæ, lepades, sertularia, and other marine productions. The following account has been given by Dr. Sprat of the treatment of oysters.

In the month of May the oysters cast their spawn, (which the dredgers call their spats), it is like to a drop of a candle, and about the bigness of a halfpenny. The spat cleaves to stones, old oyster-shells, pieces of wood, and such like things, at the bottom of the sea, which they call cultch. It is probably conjectured, that the spat in twenty-four hours begins to have a shell. In the month of May, the dredgers (by the law of the Admiralty Court) have liberty to catch all manner of oysters of what size soever. When they have taken them, with a knife they gently raise the small brood from the cultch, and then they throw the cultch in again, to preserve the ground for the future, unless they be so newly spat that they cannot be safely severed from the cultch; in that case they are permitted to take the stone, or shell, &c. that the spat is upon, one shell having many times twenty spats. After the month of May, it is a felony to carry away the cultch, and punishable to take any other oysters, unless it be those of size (that is to say) about the bigness of a half-crown piece, or when, the two shells being shut, a fair shilling will rattle between them. The places where the oysters are chiefly catched, are called the Pont Burnham, Malden, and Colne Waters; the latter taking its name from the river of Colne, which passeth by Colne Chester, gives the name to that town, and runs into a creek of the sea at a place called the Hythe, being the suburbs of the town. This brood and other oysters they carry to creeks of the sea, at Brickel Sea, Mersey, Langno, Fingrego, Wivenho, Tolesbury, and Saltcoase, and there throw them into the channel, which they call their beds or layers, where they grow and fatten, and in two or three years the smallest brood will be oysters of the size aforesaid.

Those oysters which they would have green, they put into pits about three feet deep in the salt marshes, which are overflowed only at spring tides, to which they have sluices, and let in the salt water until it is about a foot and a half deep. These pits, from some quality in the soil co-operating with the heat of the sun, will become green, and communicate their colour to the oysters that are put into them, in four or five days; though they commonly let them continue there six weeks or two months, in which time they will be of a dark green. To prove that the sun operates in the greening, Tolesbury pits will green only in summer; but that the earth hath the greater power, Brickel Sea pits green both winter and summer; and for a further proof, a pit within a foot of a greening pit will not green; and those that did green very well, will in time lose their quality.

The oysters, when the tide comes in, lie

with their hollow shell downwards, and when it goes out they turn on the other side; they remove not from their place, unless in cold weather, to cover themselves in the ouse. The reason of the scarcity of oysters, and consequently of their dearness, is, because they are of late years bought up by the Dutch.

There are great penalties, by the Admiralty Court, laid upon those that fish out of those grounds which the court appoints, or that destroy the cultch, or that take any oysters that are not of size, or that do not tread under their feet, or throw upon the shore, a fish which they call a five-finger, resembling a spur-rowel, because that fish gets into the oysters when they gape, and sucks them out. The reason why such a penalty is set upon any that shall destroy the cultch is, because they find that if that be taken away, the ouse will increase, and the muscles and cockles will breed there, and destroy the oysters, they having not whereon to stick their spat. The oysters are sick after they have spat; but in June and July they begin to mend, and in August they are perfectly well; the male oyster is black-sick, having a black substance in the fin; the female white-sick (as they term it) having a milky substance in the fin. They are salt in the pits, salter in the layers, but salter at sea.

OSTRICH. See STRUTHIO.

OSYRIS, in botany, a genus of the Dioecia Triandria class and order. Natural order of Calycifloræ. Elæagne, Jussieu. Essential character: calyx trifid; corolla none: female, stigma roundish; drupe one-celled. There are two species, *viz.* O. alba, poet's casia, and O. japonica.

OTHERA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Berberides, Jussieu. Essential character: calyx four-parted; petals four, ovate, flat; stigma sessile; capsule. There is but one species, *viz.* O. japonica, which has a shrubby stem, with round, striated, purple branches; leaves alternate, ovate, blunt, coriaceous, spreading, an inch and half in length; petioles semicylindric, smooth; flowers axillary, aggregate, peduncled; it is a native of Japan.

OTHONNA, in botany, *African ragwort*, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx one-leafed, multifid, subcylindrical; down almost none; receptacle naked. There are twenty-seven species, among which we shall notice the O. bulbosa, bulbous African ragwort; this has a thick shrubby stalk, dividing into several branches, and rising five or six feet in height; the leaves come out in clusters from one point, spreading on every side; they are smooth, narrow at their base, enlarging gradually to their points, their edges are acutely indented like those of the holly; from the centre of their leaves arise the foot stalks of the flowers being five or six inches long, branching out into several smaller, each sustaining one yellow radiated flower; these are succeeded by slender seeds crowned with down. Almost all the Othonnas are natives of the Cape of Good Hope.

OTIS, the *bustard*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill somewhat convex; nostrils oval and open; tongue bifid and pointed; legs long, and naked above the knee; only three toes. Gmelin mentions eleven species, and Latham nine. We shall notice only the following: O. tarda, or the great bustard, is found in the plains of Europe, Asia, and Africa, but has never been observed in the New Continent. In England it is occasionally met with on Salisbury Plain, and in the wolds of Yorkshire, and formerly was not uncommonly seen in flocks of forty or fifty. It is the largest of British land birds, weighing often twenty-five or thirty pounds. It runs with great rapidity, so as to escape the pursuit of common dogs, but falls speedily a victim to the greyhound, which often overtakes it before it has power to commence its flight, the preparation for which, in this bird, is slow an laborious. The female lays her eggs on the bare ground, never more than two in number, in a hole scratched by her for the purpose; and if these are touched or soiled during her occasional absence, she immediately abandons them. The male is distinguished by a large pouch, beginning under the tongue and reaching to the breast, capable of holding, according to Linnæus, seven quarts of water. This is sometimes useful to the female during incubation, and to the young before they quit their nest; and it has been observed to be eminently advantageous to the male bird himself, who on being attacked by birds of prey, has often discomfited his enemies by the sudden and violent discharge of water upon them. These birds are solitary and shy, and feed principally upon grasses, worms, and grain. They were formerly much hunted with dogs, and considered as supplying no uninteresting diver-

rion. They swallow stones, pieces of metal, and other hard substances. Buffon states that one was opened by the academicians of France, which contained in its stomach ninety doubloons, and various stones, all highly smoothed by the attrition of the stomach. See Aves, Plate XI. fig. 1.

O. tetrax, or the little bustard, is met with in many parts of Europe, particularly in France, where it is taken by nets. It is rarely seen in England; is shy and cunning; if molested will fly about two hundred paces, and then run so fast that a man cannot overtake it. Its flesh is like that of the great bustard, rich and delicate, and it would appear worth while to attempt the domestication of both these birds.

OTTER. See Lutra.

OVAL, an oblong curvilinear figure, otherwise called ellipsis.

However, the proper oval, or egg-shape, differs considerably from that of the ellipsis, being an irregular figure, narrower at one end than at the other; whereas the ellipsis, or mathematical oval, is equally broad at each end: though, it must be owned, these two are commonly confounded together; even geometricians calling the oval a false ellipsis.

The method of describing an oval chiefly used by artificers is by a string, the length of which is equal to the greater diameter of the intended oval, and which is fastened by its extreme ends to two pins, placed in its longest diameter, then by holding it always stretched out with a pin or pencil carried round the inside, the oval is described, which will be longer or shorter, as the two fixed points are further apart.

OVIEDA, in botany, so named in honour of Gonsalvo Fernandez d'Oviedo, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Caprifolia, Jussieu. Essential character: calyx five-cleft; corolla tube subcylindric, superior, very long; berry globular, one-celled, quadripartile, four-seeded. There are two species, viz. O. spinosa, and O. mitis.

OVERSEERS *of the poor*. By 43 Elizabeth, c. 2, § 1, the churchwardens of every parish, or two substantial householders, to be nominated yearly in Easter week, or within one month after Easter, under the hand and seal of two justices of the peace of the county, shall be overseers of the same parish. In general all persons are liable to serve, with some exceptions as to peers of the realm, clergymen, parliament men, attornies, practising barristers, the president and members of the college of physicians, surgeons, and apothecaries free of the hall; dissenting ministers, prosecutors of felons, having a Tyburn ticket, and soldiers actually serving in the militia. In extensive parishes a greater number of overseers are appointed under 13 and 14 Charles II. c. 12, § 21; and by 17 Geo. II. c. 38, if an overseer dies, removes, or becomes insolvent, the justices may appoint another, and their appointment is subject to appeal to the sessions. By 43 Elizabeth, c. 2, § 2, overseers shall, within fourteen days after the appointment of new ones, deliver to them an account to be allowed by two justices, and pay over balances due from them, which, if not paid, may be levied by distress, and the party committed to prison by the justices until the balance is paid, and the account delivered in; and by 17 George II. c. 38, the account is to be verified by oath. If he removes, the overseer is to account in like manner. If he dies, his executors have forty days to account, and must pay the balance before any other debts. Their duty consists in raising the poor's-rate, taking care of the poor, giving relief to casual poor, and removing persons who come to settle in a tenement under 10*l.* a year, &c. without a certificate. They are also to bind out the children of poor persons, and in that case the infant parish apprentice and his master cannot vacate the indentures without the overseers. They also are to procure orders of maintenance of bastards to be made, and bonds to be taken from the reputed father to indemnify the parish. It has been usual for overseers in those cases, instead of taking a bond of indemnity, to accept of a sum of money and discharge the father. But this has been lately held to be illegal, because it gives the overseers an interest to procure the death of the child. In cases of removal also overseers should be careful not to execute the order in a harsh or improper manner, for if a person die in consequence of a removal at a time of sickness, the overseer may be guilty of murder, and liable to an indictment. Overseers also should not improperly conspire to force persons who are with child of bastards to marry and relieve the parish, for this also is indictable. By 17 George II. c. 38, if any person shall be aggrieved by any thing done or omitted by the churchwardens and overseers, or by any of his Majesty's justices of the peace, he may, giving reasonable notice

to the churchwardens or overseers, appeal to the next general or quarter sessions, where the same shall be heard, or finally determined; but if reasonable notice be not given, then they shall adjourn the appeal to the next quarter sessions; and the court may award reasonable costs to either party, as they may do by 8 and 9th William, in case of appeals concerning settlements. See POOR. By 43 Elizabeth, c. 2, § 2, they forfeit 20*s.* on neglecting to meet in the vestry one Sunday in the month; and by 13 and 14 Charles II. c. 4, forfeit 5*l.* for refusing relief to a person duly removed by warrant of two justices. By 9 George III. c. 37, § 7, they are to forfeit 10*s.* or 20*s.* for paying the poor in bad money.

OVERT *act*. In the case of treason, is compassing or imagining the death of the King, this imagining must be manifested by some open act; otherwise being only an act of the mind, it cannot fall under any judicial cognizance. Bare words are held not to amount to an overt act, unless put into writing; in which case they are then held to be an overt act, as arguing a more deliberate intention. No evidence is to be admitted of any overt act, that is not expressly laid in the indictment, 7 Will. c. 3.

OVIPAROUS, a term applied to such animals as bring forth their young, *ab ova*, from eggs; as birds, insects, &c.

OVIS, the *sheep*, in natural history, a genus of mammalia of the order Pecora. Generic character: the horns hollow, wrinkled, turning backwards and outwards into a spiral form; lower front teeth eight; no canine teeth. There are nine species mentioned by Shaw. The following are most worthy of attention.

O. ammon, or the Siberian sheep, or the argali. The argali, or wild sheep, is the presumed origin of all the domestic sheep. It is found on the immense chain of mountains reaching through the middle of Asia to the Eastern Ocean. In Barbary, Corsica, Sardinia, Greece, and Kamtschatka, it is also to be met with, and in some of these places in great abundance. Its size is that of a fallow deer. In Siberia the argali is fond of ranging the highest elevations, and is generally seen in small flocks. As winter approaches, they move downwards into the plains, and instead of the shoots of the mountain plants which were before their food, eat grass and other vegetables. They are extremely fond of salt, and will often remove the earth which covers this substance, in considerable quantities, in order to obtain it. Their horns grow to a vast size and weight. These animals are timid in a very great degree; but the males will occasionally engage in fierce conflicts with each other, and, it is said, endeavour to precipitate each other down the steeps of the mountains which they inhabit. They move over these rugged eminences with great agility, and the chase of them is difficult and fatiguing. They are supposed to live to the age of fourteen years.

O. aries, or the common sheep. This animal, in its state of complete domestication, appears equally stupid as it is harmless, and seems nearly to justify the observations of Buffon, who describes it as one of the most timid, imbecile, and contemptible of quadrupeds. When sheep, however, have an extensive range of pasture, and are left in a considerable degree to depend upon themselves for food and protection, they exhibit more respectability of character. A ram has been seen in these circumstances to attack and beat off a large and formidable dog, and even a bull has been felled by a stroke received between his eyes, as he was lowering his head to receive his adversary on his horns and toss him into the air. When individual efforts are unequal to the danger, sheep will unite their exertions, placing the females and their young in the middle of an irregular square, the rams will station themselves so as to present an armed front on every side to the enemy, and will support their ranks in the crisis of attack, harrassing the foe by the most formidable and sometimes fatal blows. Sheep display considerable sagacity in the selection of their food, and in the approach of storms they perceive the indications with accurate precision, and retire for shelter always to the spot which is best able to afford it. The domestic sheep is scarcely ever found (excepting in temperate latitudes) in a state approaching to perfection. In hot regions its wool degenerates into a species of hair, and in rigid climates, though the wool is fine at the roots, it is coarse towards the surface. The flesh of the animal, when it passes to great degrees, whether of heat or cold, appears also proportionally deteriorated. The wool of sheep in no country of the world attains greater excellence for the purposes of manufacture, without the assistance of any mixture, than in England. That of the Spanish breed is finer, but too short for manufacture by itself, and comparatively trifling in weight. Since England attained

any considerable advance in civilization its breed of sheep has been admired for the excellence of their fleeces, which constituted the grand material of national industry, wealth, and revenue. At present the worth of the wool annually shorn in this country is considerably upwards of two millions, and when wrought produces an amount of nearly seven millions sterling; facts which exhibit the importance of the cultivation of that animal, which is the source of all this opulence in a point of view particularly striking. There are several breeds or races in this country which have their respective admirers, and each of which will probably thrive better than others in certain soils and situations. The sheep of Lincolnshire afford the largest quantity of wool, but their flesh is more coarse and lean, and less pleasantly flavoured than that of some others. The sheep of the largest size are found in the rich district between Yorkshire and Durham, one of which was fed so highly as to weigh sixty-two pounds per quarter. These are reported to be equally prolific as they are large, and an ewe of this breed produced, at the age of two years, four young ones at a birth, and at the end of eleven months after, five more. The Dorsetshire breed is also considerably celebrated for fecundity, these are likewise highly admired for the delicacy and fine flavour of their flesh, but their wool is little in amount, though of excellent quality. In the North there is a hardy race of these animals, marked by their shaggy wool and black faces, which are admirably adapted to the bleak and mountainous tracts where they are produced, and sustain the rigour of winter in these cold situations without any inconvenience. Their eyes are wild, their movements nimble and rapid, and their flesh is peculiarly excellent. Towards the extreme points of the north of Scotland, there is a race of sheep particularly small, not exceeding six pounds per quarter in weight. The attention of noblemen and gentlemen of the first distinction has now long been directed to the cultivation of the sheep with respect to every point of its economy, its breed, its food, and the nature and degree of those attentions which will best promote its excellence, both as an article for subsistence and manufacture. These efforts, not many years since, it must be acknowledged, took a somewhat singular direction, and it appeared to be the grand object of agricultural ingenuity, to raise the animal to that superlative degree of fatness which, in all but the most robust appetites, was calculated to excite disgust. In one instance particularly, it was considered as an exploit of transcendent merit to have carried this process so far, that the fat of the animal, cut, without any slope, directly through the ribs, measured upwards of seven inches. This ludicrous, as well as pernicious and wasteful folly, has, however, now for some years, ceased. The sheep is more subject to disorders than any of the domesticated animals; giddiness, consumption, scab, dropsy, and worms, frequently seizing upon and destroying it. The last are met with in vast numbers in the liver and gall bladder of these animals. These worms belong to the genus fasciola, are flat, oval, and pointed at the extremities. The fly is another formidable enemy, and is often fatal in the course of twenty-four hours, breeding within the skull of the animal. To extricate the sheep from this danger, the French shepherds apply the trephine without the slightest hesitation, and with the greatest dispatch and success. For the common ram see Mammalia, Plate XVII. fig. 4.

The Cretan sheep is remarkable for long and large horns, twisted in the shape of a screw.

The many-horned sheep is found most commonly in the north of Europe, and most frequently in Iceland. Three, four, and even five horns, are occasionally seen on these animals in considerably different forms, sizes, and situations. See Mammalia, Plate XVII. fig. 6.

The Cape sheep is remarkable for its emaciated appearance, long neck, and pendulous ears, and for having a pair of wattles under the neck like goats.

The broad-tailed sheep occurs in various countries of Asia and Africa, and is extremely similar to the European breed in almost all respects, but that its tail is of an immense weight, varying from fifteen to fifty pounds, under which the shepherds are reported to place a board with wheels, to facilitate the animal's movements. These tails are stated to constitute the most marrowy and luxurious food.

The Tibetian sheep yield wool of admirable length and fineness, and are said to produce the material from which are fabricated the Indian shawls, which are sometimes sold in this country for between thirty and fifty pounds.

For a species of sheep called the dwarf sheep, see Mammalia, Plate XVII. fig. 5.

OUNCE, a little weight, the sixteenth part of a pound avoirdupoise, and the twelfth part of a pound troy: the ounce avoirdupoise is divided into eight drachms, and the ounce troy into twenty pennyweights. The avoirdupoise ounce is less than the troy ounce, but the avoirdupoise pound is greater than the troy pound. One hundred and seventy-five troy ounces are equal to one hundred and ninety-two avoirdupois ounces; but one hundred and forty-four pounds avoirdupois are equal to one hundred and seventy-five pounds troy. Therefore one pound avoirdupois, is equal to one pound, two ounces, eleven pennyweights, sixteen grains troy. See WEIGHT.

OVOLO, or OVUM, in architecture, a round moulding, whose profile, or sweep, in the Ionic and Composite capitals, is usually a quadrant of a circle: whence it is also commonly called the quarter round.

OUSTED, in law, means put out, or removed, as ouster of possession as to lands.

OUTLAWRY, is being put out of the law, or out of the king's protection. It is a punishment inflicted for a contempt in refusing to be amenable to the process of the higher courts. By outlawry in civil actions, a person is so put out of the protection of the law, that he is not only incapable of suing for the redress of injuries, but may be imprisoned, and forfeits all his goods and chattels, and the profits of his land; his personal chattels immediately upon the outlawry, and his chattels real, and the profits of his lands when found by inquisition. Proceeding to outlawry is usually had in civil suits where an action is brought against two partners, and one is abroad; it is then necessary to outlaw him before the other can be proceeded against.

OUTWORKS, in fortification, all those works made without side the ditch of a fortified place, to cover and defend it. Outworks, called also advanced and detached works, are those which not only serve to cover the body of the place, but also to keep the enemy at a distance, and prevent his taking advantage of the cavities and elevations usually found in the places about the counterscarp, which might serve them either as lodgments, or as rideaux, to facilitate the carrying on their trenches, and planting their batteries against the place: such are ravelines, tenailles, horn-works, velopes, crown-works, &c. It is a general rule in all outworks, that if there be several of them, one before another, to cover one and the same tenaille of a place, the nearer ones must, gradually one after another, command those that are further advanced out into the campaign, that is, must have higher ramparts, that so they may overlook and fire upon the besiegers when they are masters of the more outward works.

OWL. See STRIX.

OX. See BOS.

OXALIC *acid*, in chemistry, is found native in some acid vegetable juices, and rather plentifully in the "oxalis acetocella," or "wood-sorrel," and in other plants of the same genus; it is naturally united with a quantity of potash, not sufficient for complete saturation, forming what has been long known under the name of "Essential salt of sorrel." The oxalic acid is prepared artificially by boiling a sufficient quantity of nitric acid with a variety of vegetable and animal substances, such as sugar, mucilage, alcohol, animal jelly, &c. Take sugar as an example: one ounce in powder is put into a retort, with three ounces of strong nitric acid. During the solution, great quantities of the nitrous acid escapes: heat is to be applied till the nitrous gas is driven off. Three ounces more of nitric acid are to be added, and the boiling continued till the fumes cease, and the colour of the liquor vanishes. Pour out the liquor into a wide shallow vessel, and, when it cools, crystals will be formed, which may be collected and dried on unsized paper. The crystals thus obtained may be again dissolved in distilled water, and evaporated to obtain new crystals. In this way oxalic acid may be obtained from the substances above enumerated, and many others, as alcohol, gum, honey, &c. Prepared in this way, oxalic acid is in a concrete state, crystallized in four-sided prisms, terminated in two-sided summits. They are white and transparent, and have considerable lustre. They have a sharp taste, and change vegetable blues into a red colour, and produce the same effect on all vegetables, excepting indigo. The acid properties of this substance are so strong, that one part of concrete oxalic acid gives to 3,600 parts of water the property of reddening paper stained with turnsole. When exposed to heat it is volatilized, partly in a liquid, and also in a crystaline form. It cannot be decomposed but by a very great heat. It is deliquescent in moist air; and cold water dissolves about one-half its weight of the acid: boiling water dissolves

a quantity equal to its own weight. This acid is decomposed by the sulphuric acid with heat, and charcoal is deposited: at the boiling temperature it is decomposed by the nitric acid, and converted into water and carbonic acid: its component parts are

Oxygen	77
Carbon	13
Hydrogen	10
	100

It combines with alkalies, earths, and metallic oxides, and the salts thus formed are denominated oxalates. The great attraction which this acid has for lime renders it of great utility in detecting that substance in every soluble combination.

OXALATES, in chemistry, salts formed of the oxalic acid and certain bases, are distinguished by the following properties: when exposed to a red heat, the acid is decomposed and driven off, and the base only remains. Lime water precipitates a white powder from their solutions, provided no excess of acid be present: the earthy oxalates are in general nearly insoluble in water, but they may be rendered soluble by an excess of the more powerful acids. See Oxalic *acid*.

OXALIS, in botany, *wood-sorrel*, a genus of the Decandria Pentagynia class and order. Natural order of Gruinales. Gerania, Jussieu. Essential character: calyx five-parted; petals five, often connected at the base; capsule five-celled, five-cornered, opening at the corners; seeds arilled. There are ninety-six species, of which the O. acetosella, common wood-sorrel, has a perennial, branched, knobbed, creeping root, having fine fibrils on every side, partly red and partly white, with an ovate, acute, rigid scale, like a tooth at the knobs; scapes one or two, jointed at the base, the length of the leaves; calycine leaflets, oblong, acute, sometimes bifid, ciliate, purple at the tip, upright. Linnæus remarks, that the leaflets in wet weather are erected, but hang down in dry weather. It has been observed, that this elegant little plant has the leaves of trefoil, the taste of sorrel, and the flower of geranium; from which last genus this is distinct, in the number of styles, the form of the capsule and manner of its opening, its straight corcle, or heart, without any perisperm or albumen: it is common all over Europe.

OXGANG, or Oxgate, is generally taken, in our old law-books, for fifteen acres, or as much ground as a single ox can plough in a year.

OXIDE, in chemistry. Metallic substances are not only of vast importance in the arts of civilized life, on account of the properties which belong to them in the metallic state; but many of them are not less valuable in those changes which they undergo by new combinations, and the new properties they acquire, in consequence of these changes. One of the first and most ordinary changes to which metallic substances are subject, is their combination with oxygen. This is called, in chemical language, oxydation. If a metal, as, for instance, a piece of iron, is exposed to the air, when it is moist, it soon undergoes a remarkable change. It loses its metallic lustre, and the surface is covered, with a brownish powder, well known by the name of rust. This change is owing to the combination of oxygen with the metal, and the rust of the metal in this state is known in chemistry by the name of oxide. The process by which this compound of oxygen and a metallic substance is formed, is called oxydation, and the product is denominated an oxide. The process of oxydation is effected more rapidly when metals are exposed to the action of heat; and, indeed, many metals require a very high temperature to produce the combination, while it cannot be accomplished in others by the greatest degree of heat that can be produced. This process was formerly called calcination, or calcining the metal; and the product, now denominated an oxide, was distinguished by the name of calx or calces, from its being reduced to the state of powder, in the same way as limestone, by burning. Metals differ very much from each other in the circumstances in which this oxydation takes place, as in the temperature which is necessary, the facility of the combination, the proportions of oxygen which combine, and the force of affinity between the constituent parts of the oxide. Some metals are oxydated in the lowest temperature, as, for instance, iron and manganese; while others require the greatest degree of heat that can be applied. Such are silver, gold, and platina.

The facility with which oxydation takes place in some metals is so great, such as in iron, tin, lead, copper, and manganese, that they must be completely defended from the action of oxygen; but in gold and platina, no perceptible change is observed

for whatever length of time they are exposed to the atmosphere. This oxydation, and the quantity of oxygen absorbed, is proportional to the temperature. There are, however, many metals which combine with a determinate proportion of oxygen at certain temperatures, and from this may be estimated the quantity of oxydation from the degree of heat which has been applied. The rapidity of the oxydation is almost always increased by the elevation of temperature. In this way actual combustion or inflammation is produced. Thus filings of metals thrown upon a body in the state of ignition, give out brilliant sparks; and steel, struck upon a flint, burns with a vivid flame in the air, in consequence of the great heat which is communicated to it by percussion. Metallic substances combine with very different proportions of oxygen; and this quantity varies according to the manner in which the process has been conducted, or the temperature to which the metal has been exposed.

In these different states and conditions of oxydation different phenomena are exhibited. Sometimes the metal becomes red-hot, and is inflamed; sometimes the oxydation takes place without fusion, or does not combine with oxygen till after it has been melted; sometimes it is covered with a brittle crust, or with a substance in the form of powder. At other times a pellicle, exhibibiting different colours, forms on the surface; but, in all cases, the metal is tarnished, loses its brilliancy and its colour, and assumes another, which announces the change that has taken place. Another difference which takes place among metals, is the different degrees of force with which the oxygen adheres to the metal. The knowledge of this, and the different degrees of affinity between oxygen and metallic substances is of great importance in many operations and chemical results. During the fixation of oxygen in metallic substances, it is absorbed by some in its solid state, and gives out a great deal of caloric. In others it is combined, without giving out the same quantity. This proportion of caloric given out corresponds to the facility with which oxides part with their oxygen, or are reduced to the metallic state. Those which have combined with oxygen, with the greater proportion of caloric, are most easily reduced; but those, on the contrary, in which the oxygen has been deprived of its caloric, are reduced to the metallic state by a great addition of caloric, and the greatest number of oxides require the addition of substances whose affinity for oxygen is greater than that of the metal. Metallic oxides are extremely different in different metals, and even in the same metal, according to the proportion of oxygen. They are, however, possessed of some common properties. They are all in the form of powder or earthy substance, or so brittle as to be easily reduced to this state. They exhibit every shade of colour from pure white to brown and deep red, and they are heavier than the metals from which they have been obtained. Some oxides are revived, as it is called, or are reduced to the metallic state, merely by being in contact with light or caloric. Some require the addition of a combustible substance and a high temperature; while others have so strong an affinity for oxygen, that they cannot be deprived of it by the strongest heat, but become fusible in the fire, and afford a glassy matter more or less coloured, and even serve as a flux to the earths. Some oxides are volatile, but the greatest number are fixed. Some have an acrid and caustic taste, are more or less soluble in water, and even possess an acid quality; others are insoluble and insipid.

OXOPHYLLUM, in botany, a genus of the Monadelphia Pentandria class and order. Natural order of Trihilatæ. Meliæ, Jussieu. Essential character: one-styled; calyx five-toothed; petals five, long; filaments sheathing the style, five-toothed at top; teeth antheriferous; stigma one; capsule five-celled. There is but one species, viz. O. fœtidum; this is a shrub about ten feet in height, and nearly six inches in diameter; the bark is green and smooth, the wood white, tender, and fragile; the branches twiggy, garnished with alternate leaves, each leaf digitated, having three large lobes growing on a foot-stalk of five or six inches in length; each lobe is divided by a longitudinal nerve, which is prominent beneath; the flowers spring from the bosoms of the leaves, at the extremity of the twigs and branches; their common footstalk is about a foot in height, dividing at its summit into several smaller ones, on each of which are placed alternate sessile flowers; the corolla is white, each petal being an inch long, and, as it were, glued to each other longitudinally by their borders, so as to form a kind of tubular figure, the upper part spreading; these petals cover a white membranaceous tube, which on its upper part divides into five short fila-

ments, supporting at their points the anthers. This shrub is a native of the forests of Guiana, flowering in February.

OXYDATION, } sometimes spelt
OXYGENATION, } OXIDATION, &c. See OXIDE. See also Murray's "Chemistry," vol. ii. for the proper use of the several terms.

OXYDIZEMENT, } terms used by
OXYGENIZE, } some authors for OXYDATION, OXYGENATION, &c. which see.

OXYGEN, in chemistry, is one of the most important agents in nature; there is scarcely a single process, either natural or artificial in which oxygen has not a share, but it is known only in combination with other bodies. "Oxygen," says Mr. Murray, "denotes the solid base or gravitating matter, and oxygen gas is the name given to it, when it exists in the ærial form." There are two vast sources whence oxygen is derived, viz. water and air; in the former it is condensed into the liquid form, and combined with about one-third of its weight of hydrogen; in the latter it is united with an azote, and forms about one-fifth of the atmosphere. Besides these, there are a multitude of other sources, such as many parts of the organized world, vegetable or animal, mineral acids and metallic oxides. Oxygen has a greater tendency to combination, than any other chemical agent. It is necessary to support combustion, and during the process it combines with the combustible body. The products are compounds of oxygen, and are both numerous and important agents in chemistry. The acids are of this kind, and their activity is principally dependent on their oxygen, which they yield readily to other bodies, and which by the dense state in which it exists, is often capable of exerting powerful affinities. All the metals, likewise, are capable of combining with this principle, from which a number of compounds are formed. See GAS, *oxygen*.

OXYGENATED *muriatic acid*, in chemistry, is prepared in the following manner; take equal parts of the oxide of manganese, and the red oxide of mercury or lead; put them into a glass retort, and add four parts of concentrated muriatic acid. This, on distillation, affords a quantity of yellow aeriform fluid, which is oxygenated muriatic gas; this being agitated with water combines with it and forms oxygenated muriatic acid. The gas is yellow and transparent, and possesses a most suffocating smell. It instantly extinguishes flame, and animal life; but has been long used for bleaching.

OXYGONE, in geometry, is an acute angled figure, or such, each of the angles of which is less than 90°. The term is chiefly applied to triangles, where the angles are all acute.

OYER *of a deed*, in law, is when a man brings an action upon a deed, bond, &c. and the defendant appears and prays that he may hear the bond, &c. wherewith he is charged; and the same shall be allowed him. And he is not bound to plead till he has it, paying for the copy of the instrument. It is then set forth upon the pleadings.

OYER and TERMINER, in law, is a court by virtue of the King's commission, to hear and determine all treasons, felonies, and misdemeanors. This commission is usually directed to two of the judges of the circuit, and several gentlemen of the county; but the judges only are of the quorum, so that the rest cannot act without them.

OYER *of the records*, in law, is a petition made in court, that the judges for more satisfactory proof, will be pleased to hear or look upon any record.

O YES, corrupted from the French *oyez*, hear ye, is an expression used by the crier of a court, in order to enjoin silence, when any proclamation is made.

OYSTER. See OSTREA.

OZANAM (JAMES), in biography, an eminent French mathematician, was descended from a family of Jewish extraction, but which had long been converts to the Romish faith; and some of whom had considerable places in the parliament of Provence. He was born at Boligneaux, in Bressia, in the year 1640; and being a younger son, though his father had a good estate, it was thought proper to breed him to the church, that he might enjoy some small benefices which belonged to the family, to serve as a provision for him. Accordingly he studied divinity four years; but then, on the death of his father, he devoted himself entirely to the mathematics, to which he had always been strongly attached. Some mathematical books which fell into his hands first excited his curiosity; and by his extraordinary genius, without the aid of a master, he made so great a progress, that at the age of fifteen he wrote a treatise of that kind.

For a maintenance, he first went to Lyons to teach the mathematics, which answered very well there; and after some

time his generous disposition procured him still better success elsewhere. Among his scholars were two foreigners, who expressing their uneasiness to him at being disappointed of some bills of exchange for a journey to Paris, he asked them how much would do, and being told fifty pistoles, he lent them the money immediately, even without their note for it. Upon their arrival at Paris, mentioning this generous action to M. Dagnesseau, father of the Chancellor, this magistrate was touched with it, and engaged them to invite Ozanam to Paris, with a promise of his favour. The opportunity was eagerly embraced; and the business of teaching the mathematics here soon brought him in a considerable income; but he wanted prudence for some time to make the best use of it. He was young, handsome, and sprightly; and much addicted both to gaming and gallantry, which continually drained his purse. Among others, he had a love intrigue with a woman who lodged in the same house with himself, and gave herself out for a person of condition. However, this expense, in time, led him to think of matrimony, and he soon after married a young woman without fortune. She made amends for this defect, by her modesty, virtue, and sweet temper; so that though the state of his purse was not amended, yet he had more home-felt enjoyment than before, being indeed completely happy in her as long as she lived. He had twelve children by her, who mostly all died young; and he was lastly rendered quite unhappy by the death of his wife also, which happened in 1701. Neither did this misfortune come singly; for the war breaking out about the same time, on account of the Spanish succession, it swept away all his scholars, who being foreigners, were obliged to leave Paris. Thus he sunk into a very melancholy state; under which, however, he received some relief and amusement from the honour of being admitted this same year an *eleve* of the Royal Academy of Sciences.

He seems to have had a presentiment of his death from some lurking disorder within, of which no outward symptom appeared. In that persuasion he refused to engage with some foreign noblemen, who offered to become his scholars, alledging that he should not live long enough to carry them through their intended course. Accordingly he was seized soon after with an apoplexy, which terminated his existence in less than two hours, on the third of April, 1717, at 77 years of age.

Ozanam was of a mild and calm disposition, a cheerful and pleasant temper, endeared by a generosity almost unparalleled. His manners were irreproachable after marriage; and he was sincerely pious and zealously devout, though studiously avoiding to meddle in theological questions. He used to say, that it was the business of the Sorbonne to discuss, of the Pope to decide, and of a mathematician to go straight to heaven in a perpendicular line. He wrote a great number of useful books.

P.

P, Or *p*, the fifteenth letter, and eleventh consonant of the alphabet; the sound of which is formed by expressing the breath somewhat more suddenly than in forming the sound of *b*: in other respects, these two sounds are very much alike, and are often confounded one with another. When *p* stands before *t* or *s*, its sound is lost, as in the words *psalms*, *Ptolemaic*, *ptisan*, &c. when placed before *h*, they both together have the sound of *f*, as in *philosophy*, *physic*, &c.

In the Italian music, P. stands for piano, or softly; P P. for piu piano, i. e. more softly; and P P P. for pianissimo, or very softly.

Among astronomers, P. M. is used to denote post meridian, or afternoon; and sometimes for post mane, i. e. after midnight.

As a numeral, P. signifies the same as G. viz. 400; and with a dash over it, thus $\bar{P}$, 400,000.

Among physicians, P. denotes pugil, or the eighth part of an handful; P. Æ.

partes æquales, or equal parts of the ingredients; P. P. signifies pulvis patrum, i. e. the Jesuits-powder; and ppt. præparatus, prepared.

PACE, a measure taken from the space between the two feet of a man, in walking; usually reckoned two feet and an half, and in some men a yard or three feet. See MEASURE.

The geometrical pace is five feet; and 60,000 such paces make one degree of the equator.

PACKERS, persons whose employment it is to pack up all goods intended for exportation; which they do for the great trading companies and merchants of London, and are answerable if the goods receive any damage through bad package.

PACO, a species of the Camelus, found in Peru.

PÆDERIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: contorted; berry void, brittle, two-seeded; style bifid. There are two species, viz. P. fœtida, and P. fragrans, the former is a native of the East Indies, and the latter of the island of Mauritius.

PÆDEROTA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: corolla four-cleft; calyx five-parted; capsule two-celled. There are three species.

PÆONIA, in botany, *peony*, a genus of the Polyandria Digynia class and order. Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx five-leaved; petals five; styles none; capsule many-seeded. There are five species, of which P. albiflora, white-flowered peony, has the root composed of a few cylindrical or fusiform tubers, united at top; stem, from a radical leafless sheath, two feet in height, slender, round; leaves alternate on long petioles; leaflets three-parted; the whole plant is very smooth and shining; the calyx is raised above the floral leaf on a short thick peduncle; petals eight, very large, milk white, oval, concave, stamens about one hundred and fifty, with the filaments as well as anthers yellow; within the stamens is a fungose, subcontinuous, lobed crown, more slender than in its congeners; the germs are smooth, conical, purple at the tip; stigma compressed into a comb or crest, suborbicular, hooked; seeds when ripe of a yellowish testaceous colour. It is a native of Siberia; it is well known among the Daurians and Mongols on account of the root, which they boil in their broth; the seeds they grind to put into their tea.

PAGANISM, the religion of the Heathen nations, in which the Deity is represented under various forms, and by all kinds of images, or idols; it is therefore called idolatry, or image worship. The theology of the Pagans was of three sorts, viz. fabulous, natural, and political or civil. The first treats of the genealogy, worship, and attributes of their deities; who were, for the most part, the offspring of the imagination of poets, painters, and statuaries. To their gods were given different names and opposite attributes, ascribing to them every species of vice, as well as to some of them every virtue. There is, however, in the delightful fictions of Homer and Hesiod, much that is entertaining, curious, and even useful. The flowers of the garden and the field, whose beauties we so much admire, were once thought to be produced by the tears of Aurora, the goddess of the morning, whose rose-coloured fingers open the gates of the east, pour the dew upon the earth, and make the flowers grow. When the leaves were agitated, or the long grass of the meadows performed its graceful undulations, all was put in motion by the breath of Zephyrus, the god of the west-wind. The murmurs of the waters were the sighs of the Naïades: little deities who presided over rivers, springs, wells, and fountains. A god impels the wind; a god pours out the rivers; grapes are the gift of Bacchus; Ceres presides over the harvest; orchards are the care of Pomona. Does a shepherd sound his reed on the summit of a mountain, it is Pan, who, with his pastoral pipe, returns the amorous lay. When the sportsman's horn rouses the attentive ear, it is Diana, armed with her bow and quiver, and more nimble than the stag that she pursues, who takes the diversion of the chace. The sun is a god, riding on a car of fire, diffusing his light through the world; the stars are so many divinities; who measure with their beams the regular progress of fire; the moon presides over the silence of the night, and consoles the world for the absence of her brother. Neptune reigns in the sea, surrounded by the Nereïdes, who dance to the joyous shells of the Tritons. In the highest heaven is seated Jupiter, the master and father of men and gods. Under his feet roll the thunders, forged by the Cyclops in the caverns of Etna; his smile

rejoices nature, and his nod shakes the foundation of Olympus. Surrounding the throne of their Sovereign, the other divinities quaff nectar from a cup, presented them by the young and beautiful Hebe. In the middle of the great circle shines, with distinguished lustre, the unrivalled beauty of Venus, alone adorned with a splendid girdle, in which the graces and sports for ever play; and in her hand is a smiling boy, whose power is universally acknowledged by heaven and earth. Music, poetry, dancing, and the liberal arts, are all inspired by one or other of the nine muses; while the votaries of martial glory derive their courage and success from Mars, the god of battles. Such is a general outline of the pleasing and inoffensive part of the fabulous theology of the Pagan world. On the other hand, as we have already intimated, many of the gods of the ancients possessed attributes at once disgraceful to, and unworthy of deity, and hurtful to the interests of morality and human happiness. Jupiter himself set an example of lust; and Bacchus was worshipped with cruel and obscene revellings.

Many, however, of the heathen writers condemned this part of their theology; amongst which are Sanchoniatho, the Phenician; and among the Greeks, Orpheus, Hesiod, and Pherecyde.

The natural theology of the Pagans was studied and taught by the philosophers, who rejected the multiplicity of gods introduced by the poets, and brought their theology to a more rational form. Some of them seem to have possessed considerable knowledge respecting the unity of the Supreme Deity: yet even Socrates, the best man and wisest of the philosophers of the Pagan world, so far yielded to the prejudices and practices of the age in which he lived, as to order his friends, just before his death, to sacrifice a cock to Esculapius, the god of physic.

The political or civil theology of the Pagans was instituted by legislators, statesmen, and politicians. This chiefly respected their temples, altars, sacrifices, and rites of worship, and was properly their idolatry; the care of which belonged to the priests, who were servants of the state. These ceremonies, &c. were enjoined the commonalty to keep them in subjection to the civil power. Such was the religion of the greater part of the world before the promulgation of Christianity; and such still, in some form or other, is the religion of those parts of the world, containing a population of about 420 millions of souls; or above one-half of the inhabitants of the whole earth, where the gospel is not preached, either in its purity, or as corrupted by the doctrines of Mahomet. The Missionaries employed for the conversion of the heathen, though very zealous and very numerous, have hitherto made comparatively little progress. The Foreign and British Bible Society may possibly have some beneficial effects in enlightening the darkness of the pagan world; but, we are persuaded, nothing but conquest and civilization, short of miracle itself, will ever prove effectual in the extirpation of heathenism, and the final establishment of Christianity.

PAGE, a youth of state retained in the family of a prince or great personage, as an honourable servant, to attend in visits of ceremony, do messages, bear up trains, robes, &c. and at the same time to have a genteel education, and learn his exercises. The pages in the King's houshold are various, and have various offices assigned them, as pages of honour, pages of the presence chamber, pages of the back stairs, &c.

PAGEANT, a triumphal car, chariot, arch, or other like pompous decoration, variously adorned with colours, flags, &c. carried about in public shews, processions, &c.

PAGOD, or PAGODA, a name whereby the East Indians call the temple in which they worship their gods. Before they build a pagod, they consecrate the ground as follows: after having inclosed it with boards or palisadoes, when the grass is grown on the ground they turn an ash coloured cow into it, who stays there a whole day and night; and as cow-dung is thought by the Indians to be of a very sacred nature, they search for this sacred deposit, and having found it, they dig there a deep pit, into which they put a marble-pillar, rising considerably above the surface of the earth. On this pillar they place the image of the god to whom the pagod is to be consecrated. After this the pagod is built round the pit, in which the pillar is fixed. The pagod usually consists of three parts, the first is a vaulted roof supported on stone or marble columns. It is adorned with images, and, being open, all persons without distinction are allowed to enter it: the second part is filled with grotesque and monstrous figures, and no body is allowed to enter it but the bramins themselves: the third is a kind of chancel, in which the statue of the deity is placed: it is shut up with a very

strong gate. This word is sometimes used for the idol, as well as for the temple.

PAGOD, or PAGODA, is also the name of a gold and silver coin, current in several parts of the East Indies.

PAIN, is defined to be an uneasy sensation arising from a sudden and violent solution of the continuity, or some other accident in the nerves, membranes, vessels, muscles, &c. of the body; or, according to some, it consists in a motion of the organs of sense; and, according to others, it is an emotion of the soul occasioned by these organs.

PAINTING. The art of painting may not improperly be defined, a mode of conveying ideas to the mind by means of a representation of the visible parts of nature. It is a language by which, though all things cannot, many at least may be expressed, in a stronger and clearer manner than can be effected by any other; nay, it is, to its extent, a universal language; though it is only in proportion as we are accustomed to read it that we can hope to acquire ideas through its means.

The particular education of our senses or organs is undoubtedly the only mode by which those senses can be rendered serviceable to us in their full extent; for although, in their natural and uncultivated state, they are enabled to present us with tolerably clear and distinct ideas of things of a simple kind, or which differ considerably from each other; it is far otherwise when we expect from them just ideas of things complicated, or of such as differ from each other by small, nay almost imperceptible gradations. The untutored eye readily distinguishes black from white, red from blue, and purple from green; but is unable to detect the delicate transitions from one shade to another of the same colour, and still less the nicer variations of combined and complex colours.

The quickest of all operations is perhaps that of sight, and in one moment we are enabled to see many objects; but we cannot, as Leonardo da Vinci properly observes, distinguish and understand clearly more than one at a time. Upon the first sight of a page of a written or a printed book, though we observe it to be full of words, we do not discover the sense contained. No! to understand, we are obliged to read it; and in case the subject be abstruse, and our comprehensions dull, it may be necessary to peruse it two or three times before the whole sense be clearly understood by us; some there may be who never will comprehend it. The situation of that man who, from long habit, reads with facility and quickness, is likewise far removed from that of the beginner, who having little practice, can only read slowly and with difficulty.

We have judged it necessary to premise these few observations, in hopes to correct a mistaken but prevalent notion, that although a thorough conversance with painting is required ere a person be adequate to decide discreetly as to the executive parts of a work of art, to distinguish the copy from the original, or the pencils of the different masters; every man is intuitively enabled to enjoy the effect of the whole, to enter into the expression and feeling of the piece, and, in short, to judge rightly between a bad picture and a good one. Nay, a moment is sufficient for one of these self-dubbed critics to pass an irrevocable sentence on the most extensive and studied composition.

In treating the subject before us, we shall not by a slow and tedious process attempt to conduct the student of painting through the long and rugged path by which alone even a moderate degree of excellence may be attained; this would be like commencing a treatise on rhetoric with the minutiæ of orthography and grammar. We shall rather, by a short inquiry into the fundamental principles of the art, and a reference to the example of the greatest masters, draw his attention to the proper application of that mechanical skill of which we suppose him already possessed.

Invention, composition, design, expression, chiara obscura, and colouring, may perhaps not improperly be termed the great component parts of painting, unless indeed it be insisted that invention is rather the parent and director of the others to the proper objects of their attainment.

We have defined painting to be a mode of communicating ideas to the mind, by means of a representation of the visible parts of nature; and we have adopted this mode of expression, because the art can hardly be said to be confined to the mere representation of visible objects, since by delineating outward demonstrations it is enabled to convey the ideas of internal affections and mental actions. It will necessarily follow that those subjects are the most immediately within the province of our art, whose essential qualities are as it were contained in the visible parts of things, or most capable of being expressed by ob-

jects of sight; and this, though a truism, we have thought it necessary to state, as experience every day shews, that it is not sufficiently attended to. By the essential qualities of a subject, we must be understood to mean those which give it its interest.

The only means by which the painter can communicate his ideas to the spectator, or in other words, tell his story, are combinations of figures and other visible objects, the representation of gesture and the expression of countenance.

As the powers of writing, in the way of narrative, are such as to enable it to convey to the reader a just idea of a succession of transactions or events; whereas it cannot by the most laboured description give us any other than a confused or erroneous notion of the situation of a building, the windings of a river, the forms of a mountain, or the beauty and expression of a countenance; so painting, inasmuch as it is incompetent to relate the conspiracy, or record the oration, is proportionably rich in its means of description. As description is the most arduous task of language, so narration is the great difficulty of painting; a difficulty however not always insurmountable to the artist, who to a competent knowledge and practice in the several component parts of his art, adds that of judgment in the choice of his subject, as will presently appear.

In a picture, the artist must necessarily choose one point of time for his representation, but the usual doctrine that a picture can absolutely express no more than this one moment of the story, requires some illustration, as otherwise the inconsiderate might naturally be led to underrate the powers of communication given to our art. The truth we believe is, that though a picture must represent one moment of time only, yet in that representation, the memorial, as it were, of past moments, may be recorded, and the idea of future ones clearly anticipated; and though this doctrine may, upon first sight, appear opposed to generally established opinion, a little reflection will, we are assured, convince any one of its truth.

It will require very little argument to shew, that many of the bodily actions of men do indicate, and, under particular circumstances, demonstrate certain other actions to have taken place previously; which is certainly expressing the past in the present; nor will it be more difficult to find instances of a present action denoting some future one; that is, expressing the future in the present. A figure walking, or running, denotes a past, a present, and a future action. The sword of the soldier drawn and lifted up over the neck of the beautiful St. Catharine, denotes a future act or event; that of her head being severed from her body; the hardened executioner forcing his sword into the scabbard, after having performed his office, as clearly shews what has gone before.

Two things should concur to render a story eminently eligible for painting. First, the incident or act to be represented should be of an unequivocal nature; such as, when represented, can leave no doubt on the mind of the observer as to its meaning; and secondly, either the cause of the act, or its probable consequence, or result, should be such as is capable of being expressed by objects in the picture; but when both the cause or the end proposed in the act represented, and the consequence of that act, can be made evident to us in a picture, such a picture is a narration, becomes truly a dumb poesy, and creates a most lively interest in our minds, possessing as it does, those properties which, as Aristostle observes, are necessary to the perfection of a drama; a beginning, a middle, and an end.

When we behold a representation of the Corinthian maid tracing the shadow of her favoured youth on the wall, love, the cause of the action, is rendered apparent by the endearments attending it: the consequence, which we are told was the invention of painting, is not evident to one uninformed of the tradition. Not so in Mr. Fuseli's pathetic composition of Paolo and Francesca, from Dante. Here we are at a loss as to no one of these particulars; the picture in every respect explaining itself with as much force, and as unequivocally as the poem. Love urges the stolen kiss and guilty dalliance, and the consequence is as evidently the destruction of the lovers by the avenging and uplifted hand of the insulted husband.

Invention, in painting, consists principally in three things: first, the choice of a subject properly within the scope of the art; secondly, the seizure of the most striking and energetic moment of time for representation; and lastly, the discovery and selection of such objects, and such probable incidental circumstances, as, combined together, may best tend to develope the story, or augment the interest of the piece. The cartoons of Raffaele, at Hampton Court, furnish us with an example of genius and

sagacity in this part of the art, too much to our present purpose to be omitted. We shall describe it in the words of Mr. Webbe. "When the inhabitants of Lystra are about to offer sacrifice to Paul and Barnabas, it was necessary to let us into the cause of all the motion and hurry before us; accordingly, the cripple, whom they had miraculously healed, appears in the crowd: observe the means which the painter has used to distinguish this object, and of course to open the subject of his piece. His crutches, now useless, are thrown to the ground; his attitude is that of one accustomed to such a support, and still doubtful of his limbs; the eagerness, the impetuosity, with which he solicits his benefactors to accept the honours destined for them, point out his gratitude, and the occasion of it: during the time that he is thus busied, an elderly citizen, of some consequence, by his appearance, draws near, and lifting up the corner of his vest, surveys with astonishment the limb newly restored; whilst a man of middle age, and a youth, looking over the shoulder of the cripple, are intent on the same object. The wit of man could not devise means more certain of the end proposed; such a chain of circumstances is equal to a narration; and I cannot but think, that the whole would have been an example of invention and conduct, even in the happiest age of antiquity." The works of the first restorers of painting may be likewise studied with great profit, so far as relates to invention, composition, and expression. In the executive parts of the art they seldom approach even mediocrity: less able therefore to gratify the eye, the artist applied himself exclusively to interest the mind of the spectator. Amongst the frescoes of Giotto, in the church of St. Francis, at Assisi, is one which, from the ingenuity of its invention, seems particularly to claim a place here. The subject is that of a wounded man, who, given over by his physician, is miraculously healed in a vision by St. Francis. The chief group of the picture represents the sick man, who, extended on his bed, is looking up with a stedfast countenance at the saint, who is laying his hand upon the wound. Two angels accompany St. Francis, one of whom holds a box of ointment. In another part of the picture the physician is represented about to go out of the room door, followed by a woman, evidently a sister or near relative of the wounded man, who, with a taper in her hand, has been conducting him to the bedside. She is earnestly attentive to what the physician is saying to the father, who has been waiting for them at the outside of the door, and who shews by his gestures, which the tears of the young woman corroborate, that no hopes are given of his son's recovery.

In the two pictures last mentioned, the different figures admitted were essential to the perfect explanation of the story. Sometimes, however, a group, or figure, which although not necessary, shall nevertheless appear naturally, as it were, to grow out of the subject, may be introduced with great augmentation of the expression and effect of the piece. Such was the pathetic episode of Aristides, so repeatedly imitated in modern times by Poussin, and other painters. A town taken by storm was the subject of this picture, in one part of which an infant was introduced creeping to the breast of its mother, who, though expiring from her wounds, yet expressed the strongest apprehension and fear lest the course of her milk being stopped, the child should suck her blood.

The judicious disposal of the materials furnished by the imagination, or invention, in such a manner as best to contribute to the beauty, the expression, and the effect of the picture, constitutes what is termed composition in painting. And here we must observe, that the different parts of the art, before mentioned, are so intimately connected with, and so dependant on each other, that the separate discussion of them must ever be attended with great difficulty, and necessarily occasion a frequent recurrence to similar arguments and principles. Composition is more especially inseparable from the rest, as not only the necessary expression of the subject and the forms and distribution of the groups, but likewise the consequent lights and shades resulting from such forms and distribution, the contrast and variety of the characters, and even the principal masses of colour, all, in a certain degree, come under the consideration of the artist, even when making his first sketch.

It were in vain to prescribe any other general rule for the distribution of the figures in a picture, except such as is dictated by the peculiar circumstances and character of the story to be represented. Much has been said of the pyramidical group, the serpentine line, the artificial contrast, and, upon doctrines like these, Lanfranco, Cortona, Giordano, Maratti, and many others, their predecessors, as well

as followers, formed a style better calculated to amuse the eye than to satisfy the judgment: an inordinate but ill directed thirst of variety is the basis of this artificial system; contrast is succeeded by contrast, opposition by opposition; but as this principle pervades all their works, the result is no variety at all, and their conduct may be compared to that of the voluptuary, who, grasping at every enjoyment which presents itself, acquires satiety instead of pleasure. Each subject, however different its character, is composed in a manner so similar to the other, that the spectator may view a gallery of such pictures, seldom discovering the subjects they are intended to represent, and without being afterwards enabled to call to mind one prominent feature distinguishing the one from the other.

If Raffaele can be said to have regulated his compositions by any particular rule or maxim, it was that of making each as unlike the other as possible, consistent with propriety of expression. Thus, in the cartoon of Christ giving the keys to Peter, the Apostles, all crowding together to be witnesses of the action, occupy the principal part of the picture, and form a group in profile, the Saviour, although in the corner of the picture, being nevertheless rendered evidently the principal figure, by the insulated situation given to him, as well as by the actions of the Apostles, who all press forward towards him, as to the centre of attraction. This cartoon is finely contrasted by the magnificent composition representing the death of Ananias, where the Apostles form a group in the centre, and are all seen in front. That of Peter and John healing the cripple at the beautiful gate of the temple, is again strikingly different from either of its companions, Raffaele having there, with a boldness of which any but a sublime genius would have been incapable, intersected his composition by the columns of the portico. But though divided, it is true, into separate and almost equal parts, neither the unity of action, nor the expression of the picture, is impaired, whilst the effect produced is at once novel and beautiful.

In the process of painting, design may properly be said to follow next after composition; for although this part of the art is, in a certain degree, requisite, even in making the first rough sketch, it is not until afterwards that the artist exerts his utmost powers to give that exact proportion, that beauty of contour, and that grace and dignity of action and deportment to his figures which constitute the perfection of design: that which was first only hinted at is now to be defined: a few rude and careless lines were sufficient in the sketch to indicate the general attitude and expression of the figure, now the utmost precision is required, not only in the outline of the naked parts, but even in the delineation of the most complicated windings of a lock of hair, or the intricate folds of a drapery. A very high degree of excellence in design, is perhaps justly considered the greatest difficulty of painting. Many of the works of Raffaele, and his school, leave nothing to be desired on the score of composition and expression. Colouring was carried to its highest pitch by Giorgione and Titian; chiaro-scuro by Coreggio, Rubens, Rembrant, and others of the Dutch school; but any thing approaching to perfection of design, if we except some of the figures of the great Michael Angelo, is rarely to be witnessed in the productions of modern art. The noble works of Grecian sculpture still remaining, sufficiently declare the decided superiority of the ancients in this particular; a superiority indeed which the most enlightened judges have never ventured to dispute.

The light clothing of the Grecian youth, which only half concealed the forms it covered, whilst it allowed full scope to the action and growth of the limbs; their ceremonies, their athletic games and dances, frequently performed naked; the great respect in which the arts of design were held amongst them, insomuch that the most beautiful of both sexes aspired to become the models of the painter or the sculptor: all these advantages, independently perhaps of some others which might be named, the artists of antiquity exclusively enjoyed, and we cannot therefore be surprised that their minds were better stored with the ideas of fine form, and that they were better enabled to discriminate between the different degrees of beauty, and the varieties of character in the human frame, than is the lot of modern artists unaided as they are by such opportunities of study.

The most perfect knowledge of form, however, only constitutes a part of that branch of painting which we term design: the art of fore-shortening, by which a limb, or a figure, although only occupying a diminished space on the canvas, is rendered, in appearance, of its full length and magnitude, is an equally indispensable object of

the artist's attainment. The sculptor, when he has chisseled or modeled the form of his figure or group, with its just proportions, has completed his work, which is rather the simple transcript than the imitation of the image previously formed in his mind: his art is undisguised, and without illusion: it presents as well to our touch as to our sight, the bodies and shapes of things without the colour. The distinguishing prerogative of painting, on the other hand, and that from which arises its decided advantage over every other artificial mode of representation, is its power to give upon a limited plane the appearance of boundless space. An insight to the science of perspective, and the doctrines of lights and shadows, is indispensable ere the student can hope to acquire the art of fore-shortening his figures with correctness; an art in which the great Michael Angelo has evinced such consummate skill in his frescoes in the Sestine Chapel at Rome, that they can never be sufficiently contemplated. The works of Coreggio, and in particular his two cupolas at Parma, may likewise be studied with advantage, and sufficiently prove that even the boldest fore-shortenings may on many occasions be resorted to without detriment to the beauty, the grace, or expression of the figures. In the execution of these, and most of his chief works, however, he was greatly assisted by his friend Antonio Begarelli, a celebrated Modenese sculptor, who modelled for him in clay all the figures, so that Coreggio, by placing and grouping them together as they were to be represented, was enabled to delineate, with the greatest correctness, every fore-shortening, and at the same time to acquire a truth and boldness of light and shade unattainable by any other means. And here it may be well to observe, that the trouble of preparing such models in the first instance, is amply repaid by the great facility, or rather certainty, which it gives the artist in the execution of his work. Moreover, the painter having his modelled figures before him, and being enabled, by varying the situation of his eye, to view them in every direction, will frequently discover beautiful combinations which he never dreamed of, at the same time that he is rendered less liable to the error of too often repeating the same view of a figure, or the same action, and is taught to avoid a common place mode of composition.

We have styled expression one of the component parts of painting, although, as it is wholly the result of the powers which the artist possesses of embodying his feelings by means of lines, lights and shades, and colours, it cannot truly be said to have a separate existence. But be this as it may, a thorough knowledge of the passions and the power of representing justly their various effects on the action and countenances of men, requires the most consummate skill of the painter. The more violent emotions of the soul, having naturally an instantaneous effect on the action, as well as on the countenance of the person affected, can be, with the greater facility, effectually and unequivocally expressed in painting. To delineate the nicer discriminations of gentle affections, of thought, sentiment and character, is a far more arduous task, and indeed not always crowned with success, even in the attempts of the greatest masters; this alone would be sufficient to convince us that subjects admitting of action, and strong decided expression, are more especially within the province of our art. The proper expression of the subject is, as we have before stated, the end proposed by the artist, even in the invention and composition of his piece. In the style of design, in the chiaro-scuro and colouring of the picture, the same object should be stedfastly kept in view.

Clair-obscure, or chiaro-scuro, is the art of distributing the lights and darks in a picture, in such a manner as to give at once proper relief to the figures, the best effect to the whole composition, and the greatest delight to the eye. We have said the lights and darks in a picture, because the word chiaro-scuro, properly speaking, denotes not only light and shade, but light and dark of what kind soever, and in this sense it is nearly allied to colouring, if not indeed inseparable from it. A thorough conception and knowledge of the chiaro-scuro is of the greatest importance to a painter, as it is very chiefly by the proper application of this branch of the art, that he is enabled to make the various objects in his picture appear to project or recede, according to their relative situations or distances; and thus far, indeed the principles of it are necessary to the artist, ere he can hope to render his imitation just or intelligible. But it is required in works of fine art, not only that truth should be told, or that beauty should be represented, but likewise that the one and the other should be made appear to every possible advantage; it has, therefore, ever been the study of great

painters, not only to give the due appearance of roundness or projection to the objects in their pictures, by proper lights and shadows; but likewise to unite or contrast the masses of light and dark in such a manner as to give at once the most forcible impression to the imagination, and the most pleasing effect to the eye.

Leonardo da Vinci was the first artist of modern times who treated the subject of chiaro-scuro scientifically; but although he gave great force and softness to his pictures, yet the system which he recommended, and generally adopted, of relieving the dark side of his figures by a light back ground, and the light parts by a dark one, prevented that expansion and breadth of effect which Coreggio soon after discovered, could only be attained by a contrary mode of conduct, that of relieving one shadow by another still darker, and of uniting several light objects into one great mass. The figures, as well as the other objects in the pictures of Coreggio, are at all times so disposed as naturally to receive the light exactly in those parts when it is most wanted, and best suits the effect of the whole, and yet this is done so skilfully, that neither propriety nor grace of action seems in any respect to be sacrificed in the astonishing combination.

The principal painters of the Venetian school, Giorgione, Titian, Bassan, Tintorit, and Paulo Veronese, were masters of effect; but with them this effect is more frequently the result of accordance or opposition of the local colours of the different objects composing their pictures, than of any very studied or skilful disposition of the masses of light and shadow. Rubens, the great genius of the Flemish school, united the wide expansive effect of Correggio, the richly contrasted tints of the Venetians, and the force of Caravaggio, and has only left us to regret that his magnificent and bold inventions were not designed with the purity of Raffaele, or the correctness of Buonaroti. From the scanty introduction of light in the works of Rembrant we might be led to suppose that this surprizing artist considered the illumined parts of his pictures as gems, acquiring increased lustre from their rarity; whilst the striking effects he has thereby produced, happily teaches us, how vain the attempt to limit or restrain by rules the workings of genius in the human mind. From an attentive study of the works of these great masters, the student will derive the true principles of chiaro-scuro, and be the better qualified to seize and avail himself of those transient, but beautiful effects, which nature, the great master of all, every day presents to his eyes. It remains for us to say a few words on colouring.

Colouring is the art of giving to every object in a picture its true and proper hue, as it appears under all the various circumstances or combinations of light, middle-tint, and shadow; and of so blending and contrasting the colours, as to make each appear with the greatest advantage and beauty, at the same time that it contributes to the richness, the brilliancy, and the harmony of the whole. "Should the most able master in design," says Mr. Webbe, "attempt, by that alone, a rose or grape, we should have but a faint and imperfect image; let him add to each its proper colours, we no longer doubt, we smell the rose, we touch the grape."

Colouring, like chiaro-scuro, (and the same observation applies to the other parts of the art) may be divided into two kinds; that which is necessary for rendering the imitation just and intelligible, and that which is expedient or ornamental, as contributing to render the work more impressive to the imagination, and more harmonious and delightful to the eye. In the first kind truth in the local tints is alone required; the second demands choice in their selection and distribution.

The Bellini's, of Venice, towards the close of the fifteenth century, first began to discover the beautiful effects resulting from a skilful combination, or opposition, of colours, at the same time that they attained a richness and truth in their local tints, far exceeding any thing hitherto practised. In both these qualities, however, they were soon far surpassed by their scholars, Giorgione da Castel Franco, and Titian, who, superadding to the most astonishing richness of colour the powerful light and shade of da Vinci, produced works which, in their way, have baffled all future attempts at improvement. The tone of colour of their pictures is not that of nature in her every-day garb; it is in some respects ideal, like the chiaro-scuro of Corregio and Rubens, or the design of Michael Angelo; that which may be supposed, but which is seldom found in nature: the depth and mellowness of their tints seem the effect of a tranquil, but vigorous light, shining through the heated atmosphere of a summer's evening. And here it may not be foreign to our purpose

to observe, that there seems to be nothing in the colouring of Titian and Giorgioni incompatible with the greatest purity of design, sublimity of conception, or propriety of expression; whereas the splendid extravagances, the brocaded stuffs, the gaudy trappings of the greater part of the more modern Venetians, although they were perhaps all masters of the theory of colours, are wholly inconsistent with genuine expression and true grandeur: in short, the sober senatorial dignity of Titian was soon changed for show, for glitter, and for ornament; invention, composition, design, and expression, were all made subservient to the inordinate desire of effect of colour.

The short limits of this article will not permit us to mention the numerous artists who have excelled in chiaro-scuro and colouring. These parts of the art, being more especially calculated to give pleasure to the sight, have been more generally and more successfully practised than the arduous and less flattering task of rational and expressive composition, and correct design.

In the present enquiry it has been our chief aim to enforce such arguments as are calculated to draw the attention of the reader to the legitimate end of the art; that, whilst the eye is charmed with beautiful forms, the magic of chiaro-scuro, and the richness and harmony of colours, the due expression of the subject of a piece may be attained, it were folly to deny: this union, indeed, constitutes the perfection of painting, which should convey, like fine writing, truths to the mind in language at once the most forcible and beautiful; but an attempt to point out the means by which this delight may be conveyed to the sight, would necessarily require a minute investigation of all the different modes which it is in the power of the painter to adopt in the executive departments of his art; and consequently lead us, with perhaps, after all, little prospect of success, far beyond the limits we are obliged to prescribe to ourselves.

Simplicity with variety, inequality of parts, with union in the whole, are, perhaps, the basis of all those effects in painting which give pleasure to the sight. As in a composition one group, or one figure, should strike the eye with superiority over the secondary groups, or other objects in the picture; so there should be in a picture one principal mass of light, which, however connected with others, should still predominate; and for the same reason no two colours should have equal sway in the same picture: as we are at liberty to give the chief group or figure of the composition that situation which we judge most appropriate; so there is no rule by which we are obliged to place the principal light in any one given part of the picture. In clair-obscure, an inequality of parts, a subordination of several small masses to one large one, never fails to produce richness and beauty of effect; and thus, in composition, a similar richness and beauty are the result of an opposition of several small bodies or parts, to one large and simple; and in the same manner from an arrangement of several small masses of colour in the vicinity of one large mass, the latter seems enriched, and to acquire additional consequence and beauty.

As by the addition of smaller masses of light, connected with the principal mass, that mass acquires at once greater breadth and influence, so the unity of action in a composition is in many cases powerfully augmented by a repetition of nearly the same action in two or three of the accessorial figures arranged together, one nevertheless being principal: this was the frequent custom of Raffaele, has its foundation in nature, where similar sentiments most frequently excite similar outward demonstrations, and never fails, if judiciously managed, to produce its effect.

The doctrine of contrasts is equally applicable to composition, to clair-obscure, and to colouring. As in composition the too frequent contrast of lines, or of back to front figures, is destructive of simplicity and force of expression: so the inordinate and frequent introduction of strong oppositions of lights and shadows, or of colours, produces a spotty and confused appearance, wholly subversive of breadth and grandeur of effect: the moderate and judicious use of contrasts is of the greatest use; it gives a zest to the picture, and is like the discord in music, which sheds additional sweetness on the full harmony which succeeds it.

PAIR, in anatomy, an assemblage or conjugation of two nerves, which have their origin together in the brain, or spinal marrow, and thence distributed into the several parts of the body, the one on one side, and the other on the other.

PALEÆ, in botany, thin, membranaceous, chaffy plates, springing out of a common receptacle, and intended as lines of partition between the small partial florets of compound and aggregate flowers.

PALAMEDEA, the *screamer*, in natural

history, a genus of birds of the order Grallæ. Generic character: bill conic, the upper mandible hooked; nostrils oval; toes divided nearly to their origin with a small membrane between the bottoms of each. There are two species. The horned screamer is about as large as a common turkey, and has on the crown of its head a slight horn, rising perpendicularly about three inches in length. It feeds on herbs and seeds, and, some add, on reptiles. It is found in Guiana, and other neighbouring territories of South America, principally in the low and marshy grounds. These birds are never observed but in pairs, and so faithful, tender, and constant is their attachment, that the death of one is generally attended with a degree of distress and grief which destroys the other. They are eaten by the natives while young; but their flesh is very darkly coloured, though not ill tasted. The crested screamer inhabits Brazil, and is about as large as a heron, and feeds on the same substances as that bird. It is esteemed good for the table.

PALATE, in anatomy, the flesh that composes the roof, or the upper and inner part of the mouth. See ANATOMY.

PALAVIA, in botany, so named in honour of Don Antonio Palau, an eminent botanist, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx half, five-cleft; style many-cleft; capsule many-celled; cells in a ball on the raised central receptacle. There are two species; viz. P. malvifolia, and P. moschata: these are both annuals, and natives of Lima in Peru, where they were discovered by Dombey.

PALE, a little pointed stake or piece of wood, used in making inclosures, separations, &c. The pale was an instrument of punishment, and execution, among the ancient Romans, and still continues so among the Turks. Hence, empaling, the passing a sharp pale up the fundament through the body.

PALE, in heraldry, one of the honourable ordinaries of an escutcheon; being the representation of a pale or stake placed upright, and comprehending the whole height of the coat from the top of the chief to the point. When the pale is single, it is to contain one-third of the breadth of the shield. When there are several, more properly called pallets, they are proportioned so as that two take up two-fifths of the shield, and three take up three-sevenths; and in those cases the number of pieces are specified, as well as that of those they are charged withal, &c. Pales are borne various ways, as wavy, indented, ingrailed, inverted, &c. There are also cometed and flaming pales, which are pointed, sometimes waved, &c.

PALISADE, or PALISADO, in fortification, an inclosure of stakes or piles driven into the ground, each six or seven inches square, and eight feet long, three whereof are hidden under ground. Palisadoes are generally used to fortify the avenues of open forts, gorges, half-moons, the bottoms of ditches, the parapets of covert ways, and in general all posts liable to surprize, and to which the access is easy. Palisadoes are usually planted perpendicularly, though some make an angle inclining towards the ground next the enemy, that the ropes cast over to tear them up may slip.

PALISADE, in gardening, denotes a sort of ornament; being a row of trees which bear branches and leaves from the bottom, cut and spread in manner of a wall along the side of an alley, or the like, so as to appear like a wall covered with leaves.

PALISSE, in heraldry, a bearing like a range of palisades before a fortification, represented on a fesse, rising up a considerable height, and pointed a-top, with the field appearing between them.

PALLADIUM, in chemistry, a metal discovered by Dr. Wollaston in the native platina: it is of a greyish colour, and, when polished, of considerable lustre: it is very ductile and very malleable; so that by the flatting mill it can be reduced into thin slips, which are flexible, but not very elastic. Its fracture is fibrous, and in diverging striæ, shewing a kind of crystaline arrangement. In hardness it is superior to wrought iron. Its specific gravity varies according to its perfect fusion, and, as it is more or less poreus, from hammering or flatting, from 10.9 to 11.8. It is a less perfect conductor of caloric than the other metals, and is also less expansible. When exposed to a strong heat, its surface tarnishes a little, and becomes blue, but, by increasing the heat, it again becomes bright. By a very great heat it is fused. It is not oxided by heat: its oxides formed by the action of acids are reduced by means of a high temperature. It is acted upon by a number of the acids; and the solutions formed by them may be decomposed by the alkalies and earths; precipitates being thrown down, which are generally of a beautiful orange

colour. The alkalies act likewise on palladium even in the metallic state: the action is promoted by the contact of the atmospheric air. All the metals, except gold, silver, and platina, precipitate palladium from its solution in the metallic state. Palladium combines readily with sulphur, but not with charcoal. It may be alloyed with a number of the metals. A full account of the discovery of palladium with the controversy to which it gave rise will be found in the Philosophical Transactions for the years 1802, 1803, 1804, 1805.

PALLASIA, in botany, so named in honour of Peter Simon Pallas, M. D. a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: receptacle chaffy; down none; seeds vertical, flat, margin ciliated; calyx imbricate. There is but one species; viz. P. halimifolia, a native of Lima in Peru.

PALLET, among painters, a little oval table, or piece of wood, or ivory, very thin and smooth; on, and round which, the painters place the several colours they have occasion for, to be ready for the pencil. The middle serves to mix the colours on, and to make the tints required in the work. It has no handle, but instead thereof a hole at one end to put the thumb through to hold it.

PALLET, among potters, crucible makers, &c. a wooden instrument, almost the only one they use, for forming, beating, and rounding their works: they have several kinds; the largest are oval with a handle; others are round, or hollowed triangularly; others, in fine, are in manner of large knives, serving to cut off whatever is superfluous on the moulds of their work.

PALLET, in gilding, an instrument made of a squirrel's tail, to take up the gold leaves from the pillow, and to apply and extend them on the matter to be gilt. See GILDING.

PALLET, in heraldry, is nothing but a small pale, consisting of one half of it in breadth, and therefore there are sometimes several of them upon one shield.

PALLET is also a part belonging to the balance of a watch or movement. See WATCH.

PALLET, in ship-building, is a room within the hold, closely parted from it, in which by laying some pigs of lead, &c. a ship may be sufficiently ballasted, without losing room in the hold; which, therefore, will serve for the stowing the more goods.

PALLIUM, or PALL, an archiepiscopal vestment of white woollen cloth, about the breadth of a border, made round, and thrown over the shoulders. Upon this border there are two others of the same matter and form, one of which falls down upon the breast, and the other upon the back, each having a red cross upon it; several crosses of the same colour being likewise upon the upper part of it about the shoulders. The pall was part of the imperial habit, and originally granted by the emperors to patriarchs; but at present it is given by the Pope as a mark of the apostolic power, without which neither the function nor title of archbishop can be assumed by the bishops of his communion.

PALM, an ancient measure, taken from the extent of the hand. The Roman palm was of two kinds: the great one was equal to about 8¼ inches English: the small one to about three inches. The modern palm differs in different countries:

	In Lines.	
At Rome it is	8	3¼
At Genoa	9	9
In France	the same	
The English palm	3	0

PALMÆ, in botany, *palms*. Under this name Linnæus has arranged several genera, which he has placed apart in an appendix to the work. The same plants constitute one of the seven families or tribes into which all vegetables are distributed by Linnæus in his "Philosophia Botanica." They are defined to be plants with simple stems, which, at their summit, bear leaves resembling those of the ferns, being a composition of a leaf and a branch; and whose flowers and fruit are produced on that particular receptacle, or seat, called a spadix, protruded from a common calyx in form of a sheath or scabbard, termed by Linnæus "spatha."

PALMÆ, is likewise the name of the first order in Linnæus's "Fragments of a Natural Method," consisting of the following genera, the three last of which, although not ranged with the palms in the appendix to his "Artificial System," are placed with them, on account of their alleged conformity in point of habit, in his "Natural Method." The plants of this order are perennial, and mostly of the shrub and tree kind. The stem is in height from two to a hundred feet, and upwards. The roots form a mass of fibres, which are commonly sim-

ple, that is, without any ramifications. In frog's-bit the roots are terminated by a small cup, of a conic form, which covers them like an extinguisher, as in duck's-meat. The stem is generally simple, cylindrical, and composed of strong longitndinal fibres; the leaves, which are a composition of a leaf and a branch, termed by Linnæus *frondes*, are of different forms, being sometimes shaped like an umbrella or fan, sometimes singly or doubly-winged; the small or partial leaves, which are often three feet in length, being ranged alternately; the branches, or principal leaves, are six, eight, ten, and twelve feet long, the length varying according to the age and size of the plant; the flowers are male and female upon the same, or different roots, except in the water-soldier, which bears hermaphrodite flowers only; and the palmetto, in which the flowers are hermaphrodite and male upon distinct roots. In vallisneria and frog's-bit too, the flowers are not so properly male and female upon different roots, as barren hermaphrodites; a small seed-bud being discovered in those called the male flowers, and the remains of stamina in the female. Abortive flowers of the same kind are frequently observed in vallisneria upon the same root. The common calyx in this order is that sort termed a spatha, or sheath, and has either one valve or opening, as in date-tree, and cocoa-nut; or two, as in faufel-nut, and wild Malabar-palm. The spadex, or head of flowers protruded from the sheath, is generally branched. Each flower is commonly furnished with a perianthium, or proper flower-cup, consisting of three leaves or divisions, that are small and permanent; the petals are three in number, of a substance like leather, and permanent like the leaves of the calyx. The flowers of zamia have no petals; the stamina are in number from two to twenty, and upwards, and cohere slightly at the base. In frog's-bit they appear like a pillar in the centre of the flower; the seed-buds are from one to three in number, placed in the middle of the flower, and support a like number of styles, which are very short. In frog's-bit, vallisneria, and water-soldier, the seed-bud is placed under the receptacle of the flower; the seed-vessel is generally a pulpy fruit of the berry or cherry kind, containing one cell, filled with fibrous flesh, and covered with a skin, which is of a substance like leather; the seeds are in number from one to three in each pulpy fruit, of a hard bony substance, round or oval, and attached by their base to the bottom of the fruit.

PALMATED, something resembling the shape of the hand: thus we say palmated leaves, roots, stones, &c.

PALSY, in medicine, a disease wherein the body, or some of its members, lose the power of motion, and sometimes their sensation of feeling.

PALY, or PALÉ, in heraldry, is when the shield is divided into four or more equal parts, by perpendicular lines falling from the top to the bottom. Palybendy is when the escutcheon is divided by perpendicular lines, which is paly; and also by diagonals, which is called bendy. See BENDY.

PANACEA, among physicians, denotes an universal medicine, or a remedy for all diseases.

PANAX, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Hederaceæ. Araliæ, Jussieu. Essential character: umbellateæ; corolla five-petalled; stamina five: hermaphrodite, calyx five-toothed, superior; styles two; berry two-seeded: male, calyx entire. There are nine species.

PANACRATIUM, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: petals six; nectary twelve-cleft; stamina placed on the nectary. There are ten species. This genus consists of perennial bulbous-rooted plants, from whence proceed long narrow leaves, and a strong upright scape, two feet in height, terminated by a large spathe, bursting on one side, disclosing in some of the species, many; in others only one or two white flowers of great elegance and fragrance. They are chiefly natives of America and the West Indies.

PANCREAS, in anatomy, popularly called the sweet-bread, is a large gland, of a flattish shape and fleshy colour, extended behind the stomach, and reaching from the duodenum transversely towards the spleen. See ANATOMY.

PANCREATIC *juice*, a liquid secreted by the pancreas, which is found to be analogous to saliva, and probably serves the same purpose in promoting the digestion of the food. See PHYSIOLOGY.

PANDANUS, in botany, a genus of the Dioecia Monandria class and order. Essential character: calyx and corolla none: male, anther sessile, inserted into the rami-

fications of the spadix: female, stigmas two; fruit compound. There is but one species, viz. P. odoratissimus, sweet-scented pandanus. It is a native of the warmer parts of Asia, where it is much used for hedges; it grows readily from branches; the tender white leaves of the flowers yield that most delightful fragrance, for which they are so generally esteemed. Of all the perfumes it is by far the richest and most powerful; the lower yellow pulpy part of the drupe is sometimes eaten by the natives in times of scarcity and famine; also the tender white base of the leaves, either raw or boiled.

PANDECTS, in the civil law, collections made by Justinian's order, of five hundred and thirty-four decisions of the ancient lawyers, on so many questions occurring in the civil law; to which that Emperor gave the force and authority of law, by an epistle prefixed to them. The pandects consist of fifty books, and make the first part of the body of the civil law.

PANIC, denotes an ill-grounded terror or fright. The origin of the phrase is from Pan, one of the captains of Bacchus, who, with a few men, put a numerous army to rout, by a noise which his soldiers raised in a rocky valley favoured with a great number of echoes; for this stratagem making their numbers appear much greater than it really was, the enemy quitted a very commodious encampment, and fled. Hence all ill-grounded fears have been called panics, or panic fears.

PANICLE, in botany, denotes a soft woolly beard, on which the seeds of some plants, as millet, reeds, &c. hang.

PANICULA, in botany, a mode of flowering in which the fructifications are dispersed upon footstalks variously subdivided. It is a sort of branching or diffused spike, composed of a number of small spikes that are attached along a common footstalk. The term is exemplified in oats, panic-grass, &c.

PANICUM, in botany, *panic-grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, the third valve very small. There are seventy-nine species. For an account of this very numerous genus, we refer the reader to Martyn's edition of Miller's Botany.

PANIERS, baskets used in fortification. In military affairs the term is expressive of a man dangerous to society, of one who ought to be guarded against where confidence and discretion are necessary.

PANEL, in law, an oblong piece of parchment, containing the names of the jurors, annexed to the writ of *venire facias*, and returned by the Sheriff to the court from whence the process issued. From this the jury is often called the panel, and are said to be impanelled.

PANNAGE, or PAWNAGE, in law, the fruit of trees, as acorns, crabs, nuts, mast of beech, &c. which the swine feed upon in the woods, and which in some places the inhabitants take as a right of common.

PANNEL, in joinery, is a tympanum, or square piece of thin wood, sometimes carved, framed, or grooved in a larger piece, between two upright pieces and two cross-pieces.

PANORPA, in natural history, a genus of insects of the order Neuroptera: mouth lengthened into a cylindrical horny proboscis; feelers four, nearly equal; stemmata three; antennæ filiform, longer than the thorax; tail of the male armed with a chelate appendage: of the female unarmed. There are nine species, the most familiar is, as its name imports, P. communis, an insect very frequently seen in meadows during the early part of the summer. It is a longish bodied fly of moderate size, with four transparent wings, elegantly variegated with deep brown spots; the tail of the male insect, which is generally carried in an upright position, is furnished with a forceps, somewhat in the manner of a lobster's claw. P. coa, inhabits the Greek islands: upper wings spotted with brown, lower ones extremely narrow, and as long again as the upper pair, alternately brown and yellowish. It is much larger than the communis, and is distinguished by its beautiful colours.

PANTOMETER, the name of an instrument used to take all sorts of angles, distances, and elevations.

PAPAVER, in botany, *poppy*, a genus of the Polyandria Monogynia class and order. Natural order of Rhoeadeæ. Papaveraceæ, Jussieu. Essential character: calyx two-leaved; corolla four-petalled; capsule one-celled, opening by holes under the permanent stigma. There are nine species. See POPPY.

PAPER, sheets of a thin matter, made of some vegetable substance. The materials on which mankind have, in different ages, contrived to write their sentiments, have been extremely various; in the early ages they made use of stones, and tables of wood, wax, ivory, &c. Paper, with regard

to the manner of making it, and the materials employed therein, is reducible to several kinds; as Egyptian paper, made of the rush papyrus; bark paper, made of the inner rind of several trees; cotton paper; incombustible paper; and European paper, made of linen rags.

Egyptian paper was principally used among the ancients; being made of the papyrus, or biblus, a species of rush, which grew on the banks of the Nile: in making it into paper, they began with lopping off the two extremes of the plant, the head and the root: the remaining part, which was the stem, they cut lengthwise into two nearly equal parts, and from each of these they stripped the scaly pellicles of which it consisted. The innermost of these pellicles were looked on as the best, and that nearest the rind as the worst: they were therefore kept apart, and made to constitute two different sorts of paper. As the pellicles were taken off, they extended them on a table, laying them over each other transversely, so as that the fibres made right angles; in this state they were glued together by the muddy waters of the Nile; or, when those were not to be had, with paste made of the finest wheat flour, mixed with hot water and a sprinkling of vinegar. The pellicles were next pressed, to get out the water, then dried, and lastly flatted and smoothed by beating them with a mallet: this was the Egyptian paper, which was sometimes further polished by rubbing it with a glass ball, or the like.

Bark paper was only the inner whitish rind, inclosed between the bark and the wood of several trees, as the maple, plane, beech, and elm, but especially the tilia, or linden tree, which was that mostly used for this purpose. On this, stripped off, flatted, and dried, the ancients wrote books, several of which are said to be still extant.

Chinese paper is of various kinds; some is made of the rinds or barks of trees, especially the mulberry tree and elm, but chiefly of the bamboo and cotton tree. In fact, almost each province has its several paper. The preparations of paper made of the barks of trees may be instanced in that of the bamboo, which is a tree of the cane or reed kind. The second skin of the bark, which is soft and white, is ordinarily made use of for paper: this is beat in fair water to a pulp, which they take up in large moulds, so that some sheets are above twelve feet in length: they are completed by dipping them, sheet by sheet, in alum water, which serves instead of the size among us, and not only hinders the paper from imbibing the ink, but makes it look as if varnished over. This paper is white, soft, and close, without the least roughness, though it cracks more easily than European paper; is very subject to be eaten by the worms, and its thinness makes it liable to be soon worn out.

Cotton paper is a sort of paper which has been in use upwards of six hundred years. In the grand library at Paris are manuscripts on this paper, which appear to be of the tenth century; and from the twelfth century, cotton manuscripts are more frequent than parchment ones. Cotton paper is still made in the East Indies, by beating cotton rags to a pulp.

Linen or European paper appears to have been first introduced among us towards the beginning of the fourteenth century, but by whom this valuable commodity was invented is not known. The method of making paper of linen or hempen rags is as follows: the linen rags being carried to the mill, are first sorted; then washed very clean in puncheons, whose sides are grated with strong wires, and the bottoms bored full of holes. After this they are fermented, by laying them in heaps close covered with sacking, till they sweat and rot; which is commonly done in four or five days. When duly fermented, they are twisted into handfuls, cut small, and thrown into oval mortars, made of well-seasoned oak, about half a yard deep, with an iron plate at bottom, an inch thick, eight inches broad, and thirty long: in the middle is a washing block, grooved, with five holes in it, and a piece of hair sieve fastened on the inside: this keeps the hammers from touching it, and prevents any thing from going out, except the foul water. These mortars are continually supplied with water, by little troughs, from a cistern, fed by buckets fixed to the several floats of a great wheel, which raises the wooden hammers for pounding the rags in the mortars. When the rags are beaten to a certain degree, called the first stuff, the pulp is removed into boxes, made like cornchandlers' bins, with the bottom board aslant, and a little separation on the front, for the water to drain away. The pulp of the rags being in, they take away as many of the front boards as are needful, and press the mass down hard with their hands: the next day they put on another board, and add more pulp, till the box is full, and here

it remains mellowing a week, more or less, according to the weather. After this, the stuff is again put into clean mortars, and is beaten afresh, and removed into boxes, as before; in which state it is called the second stuff. The mass is beat a third time, till some of it being mixed with fair water, and strewed to and fro, appears like flour and water, without any lumps in it; it is then fit for the pit mortar, where it is perfectly dissolved, and is then carried to the vat, to be formed into sheets of paper. But lately, instead of pounding the rags to a pulp with large hammers, as above, they make use of an engine, which performs the work in much less time. This engine consists of a round solid piece of wood, into which are fastened several long pieces of steel, ground very sharp. This is placed in a large trough with the rags, and a sufficient quantity of water. At the bottom of the trough is a plate with steel bars, ground sharp like the former; and the engine being carried round with prodigious velocity, reduces the rags to a pulp in a very short time. It must be observed, that the motion of the engine causes the water in the trough to circulate, and by that means constantly returns the stuff to the engine. The trough is constantly fed with clean water at one end, while the dirty water from the rags is carried off at the other, through a hole, defended with wire gratings, in order to hinder the pulp from going off with the dirty water.

When the stuff is principally prepared as above, it is carried to the vat, and mixed with a proper quantity of water, which they call priming the vat. The vat is rightly primed, when the liquor has such a proportion of the pulp, as that the mould, on being dipped into it, will just take up enough to make a sheet of paper of the thickness required. The mould is a kind of sieve, exactly of the size of the paper to be made, and about an inch deep, the bottom being formed of fine brass wire guarded underneath with sticks, to prevent its bagging down, and to keep it horizontal; and further, to strengthen the bottom, there are large wires placed in parallel lines, at equal distances, which form those lines visible in all white paper, when held up to the light: the mark of the paper is also made in this bottom, by interweaving a large wire in any particular form. This mould the maker dips into the liquor, and gives it a shake as he takes it out, to clear the water from the pulp. He then slides it along a groove to the coucher, who turns out the sheet upon a felt, laid on a plank, and lays another felt on it, and returns the mould to the maker, who by this time has prepared a second sheet, in another mould; and thus they proceed, laying alternately a sheet and a felt, till they have made six quires of paper, which is called a post; and this they do with such swiftness, that, in many sorts of paper, two men make twenty posts or more in a day. A post of paper being made, either the maker or coucher whistles; on which four or five men advance, one of whom draws it under the press, and the rest press it with great force, till all the water is squeezed from it; after which it is separated, sheet by sheet, from the felts, and laid regularly one sheet upon another; and having undergone a second pressing, it is hung up to dry. When sufficiently dried it is taken off the lines, rubbed smooth with the hands, and laid by till sized, which is the next operation. For this they choose a fine temperate day, and having boiled a proper quantity of clean parchment or vellum shavings, in water, till it comes to a size, they prepare a fine cloth, on which they strew a due proportion of white vitriol and roch-alum, finely powdered, and strain the size through it, into a large tub; in which they dip as much paper at once as they can conveniently hold, and with a quick motion give every sheet its share of the size, which must be as hot as the hand can well bear it. After this the paper is pressed, hung up sheet by sheet to dry; and, being taken down, is sorted, and, what is only fit for outside quires, laid separately: it is then told into quires, which are folded and pressed. The broken sheets are commonly put together, and two of the worst quires are placed on the outside of every ream or bundle, and being tied up in wrappers, made of the settling of the vat, it is fit for sale.

Paper is of various kinds, and used for various purposes: with regard to colour, it is principally distinguished into white, blue, and brown; and with regard to its dimensions, into atlas, elephant, imperial, super-royal, royal, medium, demy, crown, fool's-cap, and pot paper.

Fig. 1, Paper Mill, is an elevation of an engine paper mill; (fig. 2) a plan; and (fig. 3) a section of it; the same letters refer to all the figures. It is contained in a square wooden chest, A B D E, lined with lead, and divided in the middle by a partition, F F; on the front and back of the chest,

two short beams, G G, *g g*, are bolted; they have long mortices through them to receive tenons, at the end of two horizontal levers, H H, which turn on bolts in one of the beams, G *g*, as centres, and are elevated or depressed by turning the nuts of two screws, *h h*, fixed to the tenon, and coming up through the top of the beams, G *g*, upon which the nuts take their bearing. Two brasses are let into the middle of the levers, H H, and form the bearing for the spindle, I I, of the engine to turn upon. K, is the cylinder, made of wood, and fixed fast upon the spindle, I I; it has a number of knives or cutters fixed on it, parallel to its axis, and projecting from its circumference about an inch. L, (fig. 3) is a circular breasting, made of boards, and covered with sheet-lead, which fits the cylinder very truly, and leaves but very little space between the teeth and the breasting, L. M, is an inclined plane, leading regularly from the bottom of the engine trough, to the top of the breasting; and N is another plane, but of smaller inclination, leading from the bottom of the breasting; at the bottom of the breasting, beneath the axis of the cylinder, a block, P, is fixed, it has cutters of the same size, and exactly similar to those in the cylinder, which pass very near to those in the block, but do not touch; this block is fixed by a dove-tail into the wooden bottom of the breasting; it comes through the wood-work of the chest, and projects a small distance from the outside of it, and is kept up to its place by a wedge, Q, (fig. 1); by withdrawing this wedge the block becomes loose, and can be removed to sharpen the cutters as occasion requires.

The cylinder is turned round with great velocity by a small pinion, E, turned by a cog-wheel, which is turned with the intervention of other wheels by a water-wheel, so as to revolve about one hundred and twenty times per minute. This great velocity draws the rags and water with which the engine-trough is filled, down between the cylinder and the fixed cutters in the block, P; and by this they are cut in pieces, and, passing round the partition, F F, come to the cylinder again: the breasting, L, by being so close to the cylinder, and its top so near the surface of the water, prevents the rags getting to the cylinder too fast, and by that means clogging it up, or raising it up from its bearing; and if any rags come to the breasting rolled up, the action of the cylinder against the breasting tends to open them, and bring them in their proper direction to the cylinder. The screws, *h h*, are used to raise or lower the cylinder, and cause it to cut finer or coarser by enlarging or diminishing the space between the cutters in the block, P, and those of the cylinder.

A cover is put over the cylinder to prevent the water and rags being thrown out of the engine by its great velocity; it is a square box, *a b d e*, and has two small troughs at *d* and *e*, coming through the sides of the box. *f g*, are two hair sieves, sliding in grooves made in each side of the box: the cylinder, as it turns, throws a great quantity of the water and rags up against these sieves; the water goes through them, and runs down the troughs at *d* and *e*, and from thence into the end of leaden pipes, *h i*, (fig. 1), by which it is conveyed away: *k l*, are grooves for two boards, which, when slid down in their places, cover the hair sieves, and stop the water going through them. A considerable part of the rags thus thrown up by the cylinder, pass quite over it, and go down under it again.

The engine is constantly supplied with fair water by a pipe, R, delivering it into a small cistern communicating with the engine; the pipe has a flannel bag tied to the end to strain the water. In large mills, two engines exactly similar are used, but one set to act finer than the other; the rags are first worked in the coarse one, and afterwards in the fine one; but some mills have but one engine, and alter it to cut fine by the screws, *h h*.

The paper proper for writing should be without knots, without any parts of the stuff not triturated, without folds, and without wrinkles, of a supple texture, its grain uniform and regular, softened in the exchange, and not destroyed by smoothing. The ground of this paper must be extremely white, or shaded with a very light blue, which adds to its natural splendor. It is of great importance that it be fully and equally sized, otherwise the writing cannot be well finished, and the turnings of the letters will be very imperfect. The paper used for drawing, or for coloured maps, is in some mills made from one kind of white stuff, either fine or middling; in others, from a mixture of three or four kinds of stuff of different colours. The Dutch were not long ago almost wholly in possession of this manufacture. The same qualities are necessary in this paper as in that for writing. The grain, however, must be a little more raised, although softened by the

exchange; for, without this grain, the pencil would leave with difficulty the traces of the objects. Great care is also necessary in the sizing of this paper, that the drawing be neatly performed, and also that the sinking of the ink or colours into the irregularities of the stuff be prevented.

The British and Dutch have had the greatest success in manufacturing pasteboard, which they make either from a single mass of stuff on the form, or from a collection of several sheets pasted together. In both cases, the sheets of pasteboard are made of stuff not rotted, and triturated with rollers, furnished with blades of well-tempered steel. By the operation of the exchange, and smoothing continued for a long time, the British and Dutch obtain solid and smooth stuffs, which neither break under the folds of cloth nor adhere to them. The stuffs not putrified have another advantage in this species of pasteboard, namely, that of resisting the action of heat, which they experience between the folds of cloth, without wasting or tarnishing, and of consequence, they may be used for a long time. In England they have at least equalled any other nation in the manufacture of this paper; and even in Scotland they have arrived at such a degree of perfection in this art, that great part of what they manufacture is sent into England. It requires to be made of a soft and equal stuff, without folds or wrinkles, of a natural whiteness, and with a shade of blue. It must be sized less strongly than writing paper, but sufficiently well to give neatness to the characters. The paper, thus properly prepared, yields easily to the printing-press, and takes a sufficient quantity of ink. The stuff must be without grease, and wrought with that degree of slowness as to make it spread equally over the form, and take a neat and regular grain; without this, the characters will not be equally marked in every part of the page; and the smallest quantity of grease renders the sizing unequal and imperfect. Some artists, with considerable success, both to meliorate the grain, and to reduce the inequalities of the surface, have submitted this paper to the exchange. And it is proper to add, that a moderate degree of exchanging and of pressing may be of great service after the sheets are printed, to destroy the hollow places occasioned by the press, and the relievo of the letters. Engraving requires a paper of the same qualities with the last mentioned, with respect to the stuff, which must be pure, without knots, and equally reduced; the grain uniform, and the sheets without folds or wrinkles. To preserve the grain, it is necessary that it be dried slowly in the lowest place of the drying house. If it is submitted to the exchange, the effects of it must be moderated with the greatest care, and the action of the two first presses must be equally distributed over the whole mass, otherwise the inequality of the moisture at the middle and sides will expose it to wrinkles in the drying. The sizing of this paper must also be moderate. These circumstances are necessary to make it receive with neatness all the soft and delicate touches of the plate. The soft and yielding paper of Auvergne possesses all those advantages; and accordingly, a great quantity of this, and of printing paper, were formerly imported into Britain and Holland from France, where they still continue to rot the materials from which they make engraving paper.

The wire-wove frame is peculiarly adapted to this kind of paper. Paper for cards must be manufactured from a pretty firm stuff, in order to take that degree of smoothness which makes the cards glide easily over one another in using. For this reason the card-makers reject every kind of paper which is soft and without strength. This paper requires to be very much sized, since the sizing holds the place of varnish, to which the smoothing gives a glazed and shining surface. To answer all these purposes, the rags require to be a little rotted, and the mallets strongly armed with iron studs.

There are three methods by which paper-hangings are painted; the first by printing on the colours; the second by using the stencil; and the third by laying them on with a pencil, as in other kinds of painting. When the colours are laid on by printing, the impression is made by wooden prints, which are cut in such a manner, that the figure to be expressed is made to project from the surface by cutting away all the other part; and this, being charged with the colours tempered with their proper vehicle, by letting it gently down on the block on which the colour is previously spread, conveys it from thence to the ground of the paper, on which it is made to fall more forcibly by means of its weight, and the effort of the arm of the person who ses the print. It is easy to conclude, tha there must be as many separate prints as there are colours to be printed. But where

there are more than one, great care must be taken, after the first, to let the print fall exactly in the same part of the paper as that which went before; otherwise the figure of the design would be brought into irregularity and confusion. In common paper of low price, it is usual, therefore, to print only the outlines, and lay on the rest of the colours by stencilling, which both saves the expense of cutting more prints, and can be practised by common workmen, not requiring the great care and dexterity necessary to the using several prints. The manner of stencilling the colours is this: the figure, which all the parts of any particular colour make in the design to be painted, is to be cut out in a piece of thin leather or oil-cloth, which pieces of leather, or oil-cloth, are called stencils; and being laid flat on the sheets of paper to be printed, spread on a table or floor, are to be rubbed over with the colour, properly tempered by means of a large brush. The colour passing over the whole is consequently spread on those parts of the paper where the cloth or leather is cut away, and give the same effect as if laid on by a print. This is nevertheless only practicable in parts where there are only detached masses or spots of colours; for where there are small continued lines, or parts that run one into another, it is difficult to preserve the connection or continuity of the parts of the cloth, or to keep the smaller corners close down to the paper; and therefore, in such cases, prints are preferable. Stencilling is indeed a cheaper method of ridding coarse work than printing; but without such extraordinary attention and trouble, as render it equally difficult with printing, it is far less beautiful and exact in the effect. For the outline of the spots of colour want that sharpness and regularity that are given by prints, besides the frequent extra lineations, or deviations from the just figure, which happens by the original misplacing of the stencils, or the shifting the place of them during the operation. Pencilling is only used in the case of nicer work, such as the better imitations of the India paper. It is performed in the same manner as other paintings in water or varnish. It is sometimes used only to fill the outlines already formed by printing, where the price of the colour, or the exactness of the manner in which it is required to be laid on, render the stencilling or printing it less proper; at other times, it is used for forming or delineating some parts of the design, where a spirit of freedom and variety, not to be had in printed outlines, are desired to be had in the work. The paper designed for receiving the flock is first prepared with a varnish-ground with some proper colour, or by that of the paper itself. It is frequently practised to print some Mosaic, or other small running figure in colours, on the ground, before the flock be laid on; and it may be done with any pigment of the colour desired, tempered with varnish, and laid on by a print cut correspondently to that end. The method of laying on the flock is this: a wooden print being cut, as is above described, for laying on the colour in such manner that the part of the design which is intended for the flock may project beyond the rest of the surface, the varnish is put on a block covered with leather or oil-cloth, and the print is to be used also in the same manner, to lay the varnish on all the parts where the flock is to be fixed. The sheet, thus prepared by the varnished impression, is then to be removed to another block or table, and to be strewed over with flock, which is afterwards to be gently compressed by a board, or some other flat body, to make the varnish take the better hold of it: and then the sheet is to be hung on a frame till the varnish be perfectly dry, at which time the superfluous part of flock is to be brushed off by a soft camel's-hair brush, and the proper flock will be found to adhere in a very strong manner. The method of preparing the flock is, by cutting woollen rags or pieces of cloth with the hand, by means of a large bill or chopping-knife; or by means of a machine worked by a horse-mill. There is a kind of counterfeit flock-paper, which, when well managed, has very much the same effect to the eye as the real, though done with less expense. The manner of making this sort is, by laying a ground of varnish on the paper; and having afterwards printed the design of the flock in varnish, in the same manner as for the true; instead of the flock, some pigment, or dry colour, of the same hue with the flock required by the design, but somewhat of a darker shade, being well powdered, is strewed on the printed varnish, and produces nearly the same appearance.

PAPER, *blotting*, is paper not sized, and into which ink readily sinks: it is used in books, &c. instead of sand, to prevent blotting; and also by apothecaries for filtering.

PAPIER *mache*. This is a substance made of cuttings of white or brown paper,

boiled in water, and beaten in a mortar till they are reduced into a kind of paste, and then boiled with a solution of gum arabic or of size, to give tenacity to the paste, which is afterwards formed into different toys, &c. by pressing it into oiled moulds. When dry, it is done over with a mixture of size and lamp-black, and afterwards varnished. The black varnish for these toys, according to Dr. Lewis, is prepared as follows. Some colophony, or turpentine, boiled down till it becomes black and friable, is melted in a glazed earthen vessel, and thrice as much amber in fine powder sprinkled in by degrees, with the addition of a little spirit or oil of turpentine now and then: when the amber is melted, sprinkle in the same quantity of sarcocolla, continuing to stir them, and to add more spirit of turpentine, till the whole becomes fluid; then strain out the clear through a coarse hair bag, pressing it gently between hot boards. This varnish, mixed with ivory-black in fine powder, is applied in a hot room on the dried paper paste, which is then set in a gently heated oven, next day in a hotter oven, and the third day in a very hot one, and let stand each time till the oven grows cold.

PAPILIO, in natural history, *butterfly*, a genus of insects of the order Lepidoptera: antennæ growing thicker towards the tip, and generally ending in a knob; wings when sitting erect, the edges meeting together over the abdomen; they fly in the day-time. The number of species under this genus (not less than 1200) renders it necessary to divide the whole into sections, which are instituted from the habit or general appearance, and, in some degree, from the distribution of the colour on the wings. We shall give the arrangement according to Linnæus, which in this instance exhibits an attempt to combine, in some degree, natural and civil history, by attaching the memory of some illustrious ancient name to an insect of a particular cast. By this plan there are five divisions, viz.

1. *Equites:* upper wings longer from the posterior angle to the tip than to the base; antennæ frequently filiform. The Equites are, Trojans, having red spots or patches on each side their breasts; or Greeks, without red marks on the breast, of gayer colours, in general, than the former, and often having an eye-shaped spot at the inner corner of the lower wings.

2. *Heliconii:* wings narrow, entire, often naked, or semi-transparent; the upper ones oblong, the lower ones very short. In some of the Heliconii the under wings are slightly indented.

3. *Danai*, from the sons and daughters of Danaus. These are divided into D. candidi and D. festivi; the wings of the former are white, of the latter they are variegated.

4. *Nymphales:* wings denticulate. Of these there are the gemmati and the phalerati; the one having eye-shaped spots either on all the wings, or on the upper or lower pair only; the others have no spots on their wings, but, in general, a great variety of colours.

5. *Plebeii:* small; the larva often contracted. These are divided into the rurales, wings with obscure spots; and the urbicolæ, wings mostly with transparent spots.

Among the Equites Troes, the P. Priamus should take the lead, not only from the corresponding dignity of the name, but from the exquisite appearance of the animal itself, which Linnæus considered as the most beautiful of the whole papilionaceous tribe. This admirable species measures more than six inches from wing's end to wing's end: the upper wings are velvet-black, with a broad band of the most beautiful grass-green, and of a satiny lustre, drawn from the shoulder to the tip, and another on the lower part of the wing, following the shape of that part, and of a somewhat undulating appearance as it approaches the tip: the lower wings are of the same green colour, edged with velvet-black, and marked by four spots of that colour; while at the upper part of each, or at the part where the upper wings lap over, is a squarish orange-coloured spot: the thorax is black, with sprinklings of lucid green in the middle, and the abdomen is of a bright yellow or gold colour. On the under side of the animal the distribution of colours is somewhat different, the green being disposed in central patches on the upper wings, and the lower being marked by more numerous black as well as orange spots. The red or bloody spots on each side of the thorax are not always to be seen on this, the Trojan monarch. The P. Priamus is a very rare insect, and is a native of the island of Amboyna.

P. Antenor is a very large species, measuring six inches and a half in extent of wings: its colour is black, with numerous cream-coloured spots and patches, and the under wings, which are tailed, or furnished with a pair of lengthened processes in the middle, are edged with a row of red cres-

cent-shaped spots. It is said to be a native of India.

Among the Equites Achivi the P. Menelaus may be considered as one of the most splendidly beautiful of the butterfly tribe. Its size is large, measuring when expanded about six inches; and its colour is the most brilliant silver-blue that imagination can conceive, changing, according to the variation of the light, into a deeper blue, and in some lights to a greenish cast: on the under side it is entirely brown, with numerous deeper and lighter undulations, and three large ocellated spots on each wing. It is a native of South America, and proceeds from a large yellow caterpillar, beset with numerous, upright, sharp, black spines. It changes into an angular chrysalis, of a brown colour, and distinguished by having the proboscis projecting in a semicircular manner over the breast; from this chrysalis, in about fourteen days, proceeds the complete insect.

The P. Machaon is an insect of great beauty, and may be considered as the only British species of Papilio belonging to the tribe of Equites. It is commonly known among the English collectors by the title of the swallow-tailed butterfly, and is of a beautiful yellow, with black spots or patches along the upper edge of the superior wings: all the wings are bordered with a deep edging of black, decorated with a double row of crescent-shaped spots, of which the upper row is blue, and the lower yellow: the under wings are tailed, and are marked at the inner angle or tip with a round red spot bordered with blue and black. The caterpillar of this species feeds principally on fennel, and other umbelliferous plants, and is sometimes found on rue. It is of a green colour, encircled with numerous black bands, spotted with red, and is furnished on the top of the head with a pair of short tentacula of a red colour, which it occasionally protrudes from that part. In the month of July it changes into a yellowish-grey angular chrysalis, affixed to some convenient part of the plant, or other neighbouring substance, and from this chrysalis in the month of August proceeds the complete insect.

Of the division called Heliconii, the beautiful insect, the P. Apollo, is an example. It is a native of many parts of Europe, but has not yet been observed in our own country, and is somewhat larger than the common great cabbage butterfly; of a white colour, with a slight semi-transparency towards the tips of the wings, which are decorated with velvet-black spots, and on each of the lower wings are two most beautiful ocellated spots, consisting of a carmine-coloured circle, with a white centre and black exterior border. The caterpillar is black, with small red spots, and a pair of short retractile tentacula in front: it feeds on orpine, and some other succulent plants, and changes into a brown chrysalis, covered with a kind of glaucous or violet-coloured powder.

Of the division entitled Danai Candidi, the common large white butterfly, or P. Brassicæ, is a familiar example. This insect is too well known to require particular description; and it may be only necessary to remind the reader that it proceeds from a yellowish caterpillar, freckled with bluish and black spots, and which changes during the autumn into a yellowish-grey chrysalis, affixed in a perpendicular direction to some wall, tree, or other object, some filaments being drawn across the thorax in order the more conveniently to secure its position. The fly appears in May and June, and is seen through all the summer.

Among the Nymphales Gemmati, few can exceed in elegance the P. Io, or peacock butterfly, a species by no means uncommon in our own country: the ground colour of this insect is orange-brown, with black bars, separated by yellow intermediate spaces on the upper edge of the superior wings, while at the tip of each is a most beautiful large eye-shaped spot, formed by a combination of black, brown, and blue, with the addition of whitish specks: on each of the lower wings is a still larger eye-shaped spot, consisting of a black central patch, varied with blue, and surrounded by a zone of pale brown, which is itself deeply bordered with black: all the wings are scalloped or denticulated. The caterpillar is black, with numerous white spots, and black ramified spines: it feeds principally on the nettle; changing to chrysalis in July, and the fly appearing in August.

Of the last division, termed Plebeii, may be adduced as an example a small English butterfly, called P. Malvæ, of a blackish or brown colour, with numerous whitish and semi-transparent spots. To this latter division also belongs a very beautiful exotic species, a native of India, and of a most exquisite lucid blue colour, edged with black, and further ornamented by having each of

the lower wings tipped with two narrow, black, tail-shaped processes. It is the P. Marsyas of Linnæus.

The larvæ of butterflies are known by the name of caterpillars, and are extremely various in their forms and colours; some being smooth, others beset with spines; some are observed to protrude from their front, when disturbed, a pair of short feelers, nearly analogous to those of a snail. A caterpillar, when grown to its full size, retires to a convenient spot, and securing itself properly by a small quantity of silken filaments, either suspends itself by the tail, hanging with its head downwards, or else in an upright position, with the body fastened round the middle by a proper number of filaments. It then casts off the caterpillar skin, and commences chrysalis, in which state it continues till the enclosed butterfly is ready for birth, which liberating itself from the skin of the chrysalis, remains till its wings, which are at first very short, weak, and covered with moisture, are fully extended: this happens in the space of a few minutes, when the animal suddenly quits the state of inactivity to which it had long been confined, and becomes at pleasure an inhabitant of the air.

PAPILIONACEI, in botany, a term applied to certain flowers, from their supposed resemblance to the figure of a butterfly. The term is applied also to the thirty-second order of Linnæus's "Fragments of a Natural Method." They are divided into two sections; viz. those that have the filaments on the stamina distinct, and those with one set of united filaments. These plants, otherwise called leguminous, from the seed-vessel, which is that sort termed a legumen, are very different both in size and duration; some of them being herbaceous, and those either annual or perennial; others, woody vegetables of the shrub and tree kind, a few of which rise to the height of seventy feet, and upwards. The herbaceous plants of this order generally climb; for being weak, and as it were helpless of themselves, indulgent nature has either provided them with tendrils, and even sharp-pointed hooks at their extremities, to fasten upon the neighbouring trees or rocks, or endued the stalks with a faculty of twisting themselves for the purpose of support around the bodies in their neighbourhood. The pea, vetch, and kidney-bean, afford familiar examples of the appearances in question. The shrubs and trees of this natural family are mostly armed with strong spines. The roots are very long, and furnished with fibres: some genera have fleshy tubercles, placed at proper intervals along the fibres. The stems are cylindric, as are likewise the young branches, which are placed alternately: those which climb twist themselves from right to left, in a direction opposite to the apparent diurnal motion of the sun. The bark of the large trees is extremely thick and wrinkled, so as to resemble a net with long meshes; the wood is very hard in the middle, and commonly coloured or veined; the alburnum is less hard, and generally of a yellow colour. The buds are hemispherical, without scales, and proceed from the branches horizontally, a little above the angle which they form with the leaves. The leaves are alternate, and of different forms, being either simple, finger-shaped, or winged. The flowers are hermaphrodite, and proceed either from the wings of the leaves, as in furze, liquorice, lupin, kidney-bean, &c. or from the extremity of the branches, as in ebony of Crete, false acacia, trefoil, coral-tree, &c. The calyx is a perianthium of one leaf, bell-shaped, branching out at the bottom, and cut on its brim or margin into five irregular divisions, or teeth, the lowermost of which, being the odd one, is longer than the rest: the other four stand in pairs, of which the uppermost is shortest, and stands furthest asunder. The bottom of the calyx is moistened with a sweet liquor, like honey, which may be deemed the nectarium of these plants. The petals are four or five in number, very irregular, and from their figure and position bear an obvious resemblance in most of the genera to a butterfly expanding its wings for flight. The stamina are generally ten in number. These are either totally distinct, as in plants of the first section; or united by the filaments into one or two bundles, involving the seed bud, as in those of the second and third. In the latter case, where there are two sets of united filaments, one of the sets is composed of nine stamina, which are united into a crooked cylinder, that is cleft on one side through its whole length. Along this cleft lies the tenth filament, or stamen, which constitutes the second set, and is often so closely attached to the large bundle, that it cannot be separated without some difficulty. The seed-bud is single, placed upon the receptacle of the flower, oblong, cylindrical, slightly compressed, of the length of the cylinder of the united stamina by which it is involved; and sometimes, as in the coral-tree, elevated by a slender foot-stalk, which

issues from the centre of the calyx. The style is single, slender, and generally crooked. In the pea the style is hairy, three-cornered, and keel-shaped above; by which last circumstance chiefly that genus is distinguished from the lathyrus, in which the style is plain. The stigma, or summit of the style, is generally covered with a beautiful down, and placed immediately under the anthers, or tops of the stamina. The seed-vessel in this order is that sort of pod termed a legumen, which is of an oblong figure, more or less compressed, with two valves, and one, two, or more cavities; these cavities are often separated, when ripe, by a sort of joints, which are conspicuous in the pods of the coronilla, French honey-suckle, horse-shoe vetch, bird's-foot, bastard sensitive-plant, and scorpiurus: the seeds are generally few in number, round, smooth, and fleshy. Jointed pods have generally a single seed in each articulation. The seeds are all fastened along one suture, and not alternately to both, as in the other species of pod termed siliqua.

The plants of this family are in general mucilaginous; from the inner bark flows a clammy liquor, which dries and hardens like gum: the juice of others, as that of the liquorice, is sweet like sugar. Some of the plants are bitter, purgative, or emetic, and some are poisonous. They are, however, emollient, useful in the healing of wounds, and astringent. See Milne's Botanical Dictionary.

PAPISTS, persons professing the Popish religion. By several statutes, if any English priest of the Church of Rome, born in the dominions of the crown of England, came from beyond the seas, or tarried in England three days without conforming to the church, he was guilty of high treason; and they also incurred the guilt of high treason who were reconciled to the see of Rome, or procured others to be reconciled to it. By these laws also, Papists were disabled from giving their children education in their own religion. If they educated their children at home,* for maintaining the schoolmaster, if he did not repair to the church, or was not allowed by the bishop of the diocese, they were liable to forfeit 10*l.* a month, and the schoolmaster was liable to the forfeiture of 40*s.* a day. If they sent their children for education abroad, they were liable to forfeit 100*l.* and the children so sent were incapable of inheriting, purchasing, or enjoying any lands, profits, goods, debts, legacies, or sums of money: saying mass was punishable by a forfeiture of 200 marks; and hearing it, by a forfeiture of 100*l.*

By statute 11 and 12 William III. c. 4, the Chancellor may take care of the education and maintenance of the protestant children of papists.

By the laws against recusancy, all persons abstaining from going to church were liable to penalties. By 35 Elizabeth, c. 2, a distinction was made against Papists, who, if convicted of recusancy, were fined 20*l.* per month, disabled from holding offices, keeping arms in their houses, suing at law, being executors and guardians, presenting to advowsons, practising law or physic; from holding offces civil or military; were subject to excommunication; could not travel five miles from home, nor come to court, under pain of 100*l.* Marriages and burials of Papists were to be according to the rites of the Church of England. A married woman convicted of recusancy lost two-thirds of her dower; she could not be executrix to her husband; might be kept in prison during marriage, unless her husband paid 10*l.* per month, or gave the third part of his lands. Popish recusants convict were, within three months after conviction, either to submit, and renounce their religious opinions, or to abjure the realm, if required by four justices; and if they did not depart, or returned without licence, were guilty of capital felony; so that abjuration was transportation for life.

But during the present reign the Roman Catholics have been in a great measure relieved from the odious and severe (if not unjust) restrictions formerly imposed on them, by the statutes 18 George III. c. 60, and 31 George III. c. 32, to which, on account of their length and consequence, the reader is referred. The principal effects of these statutes are to repeal the 11 and 12 William III. c. 4, as to prosecuting Popish priests, &c. and to disable Papists from taking lands by descent or purchase: if they take the oath expressing allegiance to the King, abjuring the Pretender, renouncing the Pope's civil power, and abhorring the doctrine of not keeping faith with heretics, and of deposing or murdering princes excommunicated by the see of Rome. The statute 31 George III. c. 32, has afforded them the most effectual relief, and consists of six parts. The first contains the oath and declaration to be taken; the second is a repeal of the statutes of recusancy in favour of persons taking that oath; the third

is a toleration, under certain regulations, of the religious worship of the Catholics, qualifying in like manner, and of their schools for education; the fourth enacts, that no one shall be summoned to take the oath of supremacy prescribed by statutes 1 William and Mary, st. 1. c. 8.; 1 George I. st. 2. c. 13; or the declaration against transubstantiation required by statute 25 Charles II. c. 2; that the statute 1 William and Mary, st. 1. c. 9, for removing Papists, or reputed Papists, from the cities of London and Westminster, shall not extend to Roman Catholics taking the appointed oath; and that no peer of Great Britain or Ireland, taking that oath, shall be liable to be prosecuted for coming into his Majesty's presence, or into the court or house where his Majesty resides, under statute 30 Charles II. st. 2, c. 1. The fifth part of the act repeals the laws requiring the deeds and wills of Roman Catholics to be registered or inrolled; the sixth excuses persons acting as counsellors at law, barristers, attornies, clerks, or notaries, from taking the oath of supremacy, or the declaration against transubstantiation. But it is adviseable to take the oath of 18 George III. 30, to prevent all doubts, or ability to take by descent or purchase.

As the statute 1 William and Mary, st. 1, c. 18, called the Toleration Act, does not apply to Catholics, or persons denying the Trinity, they cannot serve in corporations, and are liable to the test and corporation act. They cannot sit in the House of Commons, nor vote at elections, without taking the oath of supremacy; and cannot present to advowsons, although Jews and Quakers may. But the person is only disabled from presenting, and still continues patron. It seems they may serve on juries, but Catholic ministers are exempted. They also are entitled to attend the British factories and their meetings abroad, and may hold offices to be wholly exercised abroad, and may also serve under the East India Company, or in the army abroad, and the sixtieth regiment is chiefly composed of persons who cannot serve in England, by reason of the officers being many of them Catholics. This account of the state of the laws against Papists is extracted from an able review of them given by Mr. Butler, a Roman Catholic, in his Notes upon Lord Coke's Commentary on Littleton's Tenures, and which is to be found also in Tomlin's Law Dictionary, last edition, title Papist.

PAPPOPHORUM, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina, or Grasses. Essential character: calyx two-valved, two-flowered; corolla two-valved, many awned. There is but one species; *viz.* P. alopecuroideum, a native of Spanish Town in America.

PAPPUS, in botany, *thistle-down*, a sort of feathery or hairy crown, with which many seeds, particularly those of compound flowers, are furnished for the purpose of dissemination. A seed surmounted by its pappus resembles a shuttle-cock, so that it is naturally framed for flying, and for being transported by the wind to very considerable distances from its parent plant. By this contrivance of nature, the dandelion, groundsel, &c. are disseminated far and wide. In some plants, as hawk-weed, the pappus adheres immediately to the seed; in others, as lettuce, it is elevated upon a foot-stalk, which connects it with the seeds. In the first case it called pappus sessilis; in the second, pappus stipitatus: the foot-stalk, or thread, upon which it is raised is termed "stipes."

PAR, in commerce, signifies any two things equal in value; and in money affairs, it is so much as a person must give of one kind of specie to render it just equivalent to a certain quantity of another. In the exchange of money with foreign countries, the person to whom a bill is payable is supposed to receive the same value as was paid the drawer by the remitter; but this is not always the case, with respect to the intrinsic value of the coins of different countries, which is owing to the fluctuation in the prices of exchange amongst the several European countries, and the great trading cities. The par, therefore, differs from the course of exchange in this, that the par of exchange shews what other nations should allow in exchange, which is rendered certain and fixed by the intrinsic value of the several species to be exchanged: but the course shews what they will allow in exchange; which is uncertain and contingent, sometimes more, and sometimes less; and hence the exchange is sometimes above and sometimes under par. See Exchange.

PARABOLA, in geometry, a figure arising from the section of a cone, when cut by a plane parallel to one of its sides. See Conic Sections.

To describe a parabola in plano, draw a right line A B (Plate Parabola, fig. 1) and assume a point C without it; then in the same plane, with this line and point place

a square rule, D E F, so that the side D E may be applied to the right line A B, and the other E F turned to the side on which the point C is situated. This done, and the thread F G C, exactly of the length of the side of the rule, E F, being fixed at one end to the extremity of the rule F, and at the other to the point C, if you slide the side of the rule, D E, along the right line A B, and by means of a pin, G, continually apply the thread to the side of the rule, E F, so as to keep it always stretched as the rule is moved along, the point of this pin, will describe a parabola G H O.

Definitions. 1. The right line A B is called the directrix. 2. The point C is the focus of the parabola. 3. All perpendiculars to the directrix, as L K, M O, &c. are called diameters; the points, where these cut the parabola, are called its vertices; the diameter B I, which passes through the focus C, is called the axis of the parabola; and its vertex, H, the principal vertex. 4. A right line, terminated on each side by the parabola, and bisected by a diameter, is called the ordinate applicate, or simply the ordinate, to that diameter. 5. A line equal to four times the segment of any diameter; intercepted between the directrix and the vertex where it cuts the parabola, is called the latus rectum, or parameter of that diameter. 6. A right line which touches the parabola only in one point, and being produced on each side falls without it, is a tangent to it in that point.

Prop. 1. Any right line, as G E, drawn from any point of the parabola, G, perpendicular to A B, is equal to a line, G C, drawn from the same point to the focus. This is evident from the description; for the length of the thread, F G C, being equal to the side of the rule E F, if the part, F G, common to both, be taken away, there remains E G = G C. Q. E. D.

The reverse of this proposition is equally evident, viz. that if the distance of any point from the focus of a parabola, be equal to the perpendicular drawn from it to the directrix, then shall that point fall in the curve of the parabola.

Prop. 2. If from a point of the parabola, D, (fig. 2) a right line be drawn to the focus, C; and another, D A, perpendicular to the directrix; then shall the right line, D E, which bisects the angle, A D C, contained between them, be a tangent to the parabola in the point D: a line also, as H K, drawn through the vertex of the axis, and perpendicular to it, is a tangent to the parabola in that point.

1. Let any point, F, be taken in the line D E, and let F A, F C, and A C be joined; also let F G be drawn perpendicular to the directrix. Then, because (by Prop. 1), D A = D C, D F common to both, and the angle F D A = F D C, F C will be equal to F A; but F A greater than F G therefore F C greater than F G, and consequently the point, F, falls without the parabola: and as the same can be demonstrated of every other point of D E, except D, it follows that D E is a tangent to the parabola in D. Q. E. D.

2. If every point of H K, except H, falls without the parabola, then is H K a tangent in H. To demonstrate this, from any point K draw K L perpendicular to A B, and join K C; then because K C is greater than C H = H B = K L, it follows that K C is greater than K L, and consequently that the point K falls without the parabola: and as this holds of every other point, except H, it follows that K H is a tangent to the parabola in H. Q. E. D.

Prop. 3. Every right line, parallel to a tangent, and terminated on each side by the parabola, is bisected by the diameter passing through the point of contact: that is, it will be an ordinate to that diameter. For let E *e* (fig. 3 and 4) terminating in the parabola in the points E *e*, be parallel to the tangent D K; and let A D be a diameter passing through the point of contact D, and meeting E *e* in L; then shall E L = L *e*.

Let A D meet the directrix in A, and from the points E *e*, let perpendiculars E F, *e f*, be drawn to the directrix; let C A be drawn, meeting E *e* in G; and on the centre E, with the distance E C, let a circle be described, meeting A C again in H, and touching the directrix in F; and let D C be joined. Then because D A = D C, and the angle A D K = the angle C D K, it follows (4. 1.) that D K perpendicular to A C; wherefore E *e* perpendicular to A C, and C G = G H (3. 3); so that *e* C = *e* H (4. 1), and a circle described upon the centre *e*, with the radius *e* C, must pass through H; and because *e* C = *e f*, it must likewise pass through *f*. Now because F *f* is a tangent to both these circles, and A H C cuts them, the square A F = the rectangle C A H (36. 3) = the square A *f*; therefore A F = A *f*, and F E, A L, and *f e* are parallel; and consequently L E = L *e*. Q. E. D.

Prop. 4. If from any point of a parabola, D, (fig. 5) a perpendicular, D H, be drawn to a diameter B H, so as to be an ordinate

to it; then shall the square of the perpendicular, DH^2, be equal to the rectangle contained under the absciss HF, and the parameter of the axis, or to four times the rectangle HFB.

1. When the diameter is the axis; let DH be perpendicular BC, join DC, and draw DA perpendicular AB, and let F be the vertex of the axis. Then, because $HB = DA = DC$, it follows that $HB^2 = DC^2 = DH^2 + HC^2$. Likewise, because $BF = FC$, $HB^2 = 4$ times the rectangle $HFC + HC^2$ (by 8. 2). Wherefore $DH^2 + HC^2 = 4$ times the rectangle $HFB + HC^2$; and $DH^2 = 4$ times the rectangle HFB; that is, $DH^2 =$ the rectangle contained under the absciss HF, and the parameter of the axis.

2. When the diameter is not the axis: let EN (fig. 3 and 4) be drawn perpendicular to the diameter AD, and EL an ordinate to it; and let D be the vertex of the diameter.

Then shall $EN^2 =$ to the rectangle contained under the absciss, LD, and the parameter of the axis. For let DK be drawn parallel to LE, and consequently a tangent to the parabola in the point D; and let it meet the axis in K: let EF be perpendicular AB the directrix; and on the centre E, with the radius EF, describe a circle, which will touch the directrix in F, and pass through the focus C: then join AC, which will meet the circle again in H, and the right lines DK, LE, in the points PG; and, finally, let LE meet the axis in O.

Now since the angles CPK, CBA are right, and the angle BCP common, the triangles CBA, CPK are equiangular; and $AC : CB$ (or $CK : CP$) $:: OK : GP$; and $AC \times GP = OK \times CB$. Again, because $CA = 2CP$, and $CH = 2CG$, $AH = 2GP$; and consequently the rectangle $CAH = \overline{CA \times 2GP} = \overline{OK \times 2CB}$. But, $EN^2 = FA^2 =$ rectangle CAH; and consequently, $EN^2 = \overline{OK \times 2CB} =$ the rectangle contained under the absciss, LD, and the parameter of the axis. Q. E. D.

Hence, 1. The squares of the perpendiculars, drawn from any points of the parabola to any diameters, are, to one another as the abscissæ intercepted between the vertices of the diameters and the ordinates applied to them from the same points.

2. The squares of the ordinates, applied to the same diameter, are to each other as the abscissæ between each of them and the vertex of the diameter. For let EL, QR be ordinates to the same diameter DN; and let EN, QS be perpendiculars to it. Then, on account of the equiangular triangles ELN, QRS, $EL^2 : QR^2 :: EN^2 : QS^2$: that is, as the absciss DL to the absciss DR.

Prop. 5. If from any point of a parabola E (fig. 3 and 4), an ordinate, EL, be applied to the diameter AD; then shall the square of EL be equal to the rectangle contained under the absciss DL, and the latus rectum or parameter of that diameter.

For since $QR = DK$, QR^2 will be equal to $DM^2 + MK^2$; but (by case 1. of Prop. 4), $DM^2 = 4$ times the rectangle MQB; and because $MQ = QK$, $MK^2 = 4MQ^2$: wherefore $QR^2 = 4$ times the rectangle $MQB + 4MQ^2$; that is, to 4 times the rectangle QMB. But $MQ = QK = DR$, and $MB = DA$; wherefore $QR^2 = 4$ times the rectangle RDA: and because QR, EL are ordinates to the diameter AD, QR^2 (by cor. 2, of Prop. 4), : EL^2 (: RD : LD) :: 4 times the rectangle RDA : 4 times the rectangle LDA. Therefore $EL^2 = 4$ times the rectangle LDA, or the rectangle contained under the absciss LD, and the parameter of the diameter AD: and from this property, Apollonius called the curve a parabola. Q. E. D.

Prop. 6. If from any point of a parabola, A, (fig. 6) there be drawn an ordinate, AC, to the diameter BC; and a tangent to the parabola in A, meeting the diameter in D: then shall the segment of the diameter, CD, intercepted between the ordinate and the tangent, be bisected in the vertex of the diameter B. For let BE be drawn parallel to AD, it will be an ordinate to the diameter AE; and the absciss BC will be equal to the absciss AE, or BD. Q. E. D.

Hence, if AC be an ordinate to BC, and AD be drawn so as to make $BD = DC$, then is AD a tangent to the parabola. Also the segment of the tangent, AD, intercepted between the diameter and point of contact, is bisected by a tangent BG, passing through the vertex of DC.

"To draw Tangents to the Parabola." If the point of contact C be given: (fig. 7) draw the ordinate CB, and produce the axis till AT be $=$ AB; then join TC, which will be the tangent. Or if the point be given in the axis produced: take $AB = AT$, and draw the ordinate BC, which will give C the point of contact; to which draw the line TC as before. If D be any

other point, neither in the curve nor in the axis produced, through which the tangent is to pass: draw D E G perpendicular to the axis, and take D H a mean proportional between D E and DG, and draw H C parallel to the axis, so shall C be the point of contact through which, and the given point D, the tangent D C T is to be drawn.

When the tangent is to make a given angle with the ordinate at the point of contact: take the absciss A I equal to half the parameter, or to double the focal distance, and draw the ordinate I E: also draw A H to make with A I the angle H A I equal to the given angle; then draw H C parallel to the axis, and it will cut the curve in C the point of contact, where a line drawn to make the given angle with C B will be the tangent required.

"To find the Area of a Parabola." Multiply the base E G by the perpendicular height A I, and $\frac{2}{3}$ of the product will be the area of the space A E G A; because the parabolic space is $\frac{2}{3}$ of its circumscribing parallelogram.

"To find the Length of the Curve AC," commencing at the vertex. Let $y =$ the ordinate B C, $p =$ the parameter, $q = \frac{2y}{p}$, and $s = \sqrt{1 + q^2}$; then shall $\frac{1}{4}p \times (q s +$ hyp. log. of $q + s)$ be the length of the curve A C.

PARABOLA, *Cartesian* is a curve of the second order, expressed by the equation $xy = ax^3 + bx^2 + cx + d$, containing four infinite legs, *viz.* two hyperbolic ones, M M, B m, (Plate Parabola, fig. 8), (A E being the asymptote) tending contrary ways, and two parabolic legs B N, M N joining them, being the sixty-sixth species of lines of the third order, according to Sir Isaac Newton, called by him a trident: it is made use of by Des Cartes, in the third book of his Geometry, for finding the roots of equations of six dimensions by its intersections with a circle. Its most simple equation is $xy = x^3 + a^3$, and the points through which it is to pass, may be easily found by means of a common parabola, whose absciss is $ax^2 + bx + c$, and an hyperbola whose absciss is $\frac{d}{x}$; for y will be equal to the sum or difference of the correspondent ordinates of this parabola and hyperbola.

PARABOLA, *diverging*, a name given by Sir Isaac Newton to five different lines of the third order, expressed by the equation $yy = ax^3 + bx^2 + cx + d$.

PARABOLIC *asymptote*, in geometry, is used for a parabolic line approaching to a curve, so that they never meet; yet, by producing both indefinitely, their distance from each other becomes less than any given line. Maclaurin observes, that there may be as many different kinds, of these asymptotes as there are parabolas of different orders.

When a curve has a common parabola for its asymptote, the ratio of the subtangent to the absciss approaches continually to the ratio of two to one, when the axis of the parabola coincides with the base; but this ratio of the subtangent to the absciss approaches to that of one to two, when the axis is perpendicular to the base. And by observing the limit to which the ratio of the subtangent and absciss approaches, parabolic asymptotes of various kinds may be discovered.

PARABOLIC *conoid*, in geometry, a solid generated by the rotation of a parabola about its axis: its solidity is $= \frac{1}{2}$ of that of its circumscribing cylinder. The circles, conceived to be the elements of this figure, are in arithmetical proportion, decreasing towards the vertex. A parabolic conoid is to a cylinder of the same base and height, as 1 to 2, and to a cone of the same base and height, as $1\frac{1}{2}$ to 1. See the article GAUGING.

PARABOLIC *cuneus*, a solid figure formed by multiplying all the D B's (Plate Parabola, fig. 9) into the D S's; or, which amounts to the same, on the base A P B erect a prism, whose altitude is A S; this will be a parabolical cuneus, which of necessity will be equal to the parabolical pyramidoid, as the component rectangles in one are severally equal to all the component squares in the other.

PARABOLIC *pyramidoid*, a solid figure generated by supposing all the squares of the ordinate applicates in the parabola so placed, as that the axis shall pass through all the centres at right angles; in which case, the aggregate of the planes will form the parabolic pyramidoid.

The solidity hereof is had by multiplying the base by half the altitude, the reason of which is obvious; for the component planes being a series of arithmetical proportionals beginning from 0, their sum will be equal to the extremes multiplied by half the number of terms.

PARABOLIC *space*, the area contained between any entire ordinate as V V (Plate

Parabola, fig. 10), and the curve of the incumbent parabola.

The parabolic space is to the rectangle of the semi-ordinate into the absciss, as 2 to 3; to a triangle inscribed on the ordinate as a base, it is as 4 to 3.

Every parabolical and paraboloidical space is to the rectangle of the semi-ordinate into the absciss, as $r x y (m + r)$ to $x y$; that is, as r to $m + r$.

PARABOLIC *spindle*, in guaging; a cask of the second variety is called the middle frustrum of a parabolic spindle. The parabolic spindle is eight-fifteenths of its circumscribing cylinder.

PARADE, in war, is a place where the troops meet to go upon guard, or any other service. In a garrison where there are two, three, or more regiments, each have their parade appointed, where they are to meet upon all occasions, especially upon any alarm. And in a camp, all parties, convoys, and detachments have a parading place appointed them at the head of some regiment.

PARADISEA, the *bird of Paradise*, in natural history, a genus of birds of the order Picæ. Generic character: bill covered at the base with downy feathers; nostrils covered by the feathers; tail of ten feathers two of them in some species, very long; legs and feet very large and strong. These birds chiefly inhabit North Guinea, from which they migrate in the dry season into the neighbouring islands. They are used in these countries as ornaments for the head-dress, and the Japanese, Chinese, and Persians, import them for the same purpose. The rich and great among the latter attach these brilliant collections of plumage, not only to their own turbans, but to the housings and harnesses of their horses. They are found only within a few degrees of the equator. Gmelin enumerates twelve species, and Latham eight. P. apoda, or the greater Paradise bird, is about as large as a thrush. These birds are supposed to breed in North Guinea, whence they migrate into Aroo, returning to North Guinea with the wet monsoon. They pass in flights of thirty or forty, headed by one whose flight is higher than that of the rest. They are often distressed by means of their long feathers in sudden shiftings of the wind, and unable to proceed in their flight; are easily taken by the natives who also catch them with birdlime, and shoot them with blunted arrows. They are sold at Aroo for an iron nail each, and at Banda for half a rix-dollar. Their food is not ascertained, and they cannot be kept alive in confinement. The smaller bird of Paradise is supposed by Latham to be a mere variety of the above. It is found only in the Papuan islands, where it is caught by the natives often by the hand, and exenterated and seared with a hot iron in the inside, and then put into the hollow of a bamboo to secure its plumage from injury.

PARADOX, in philosophy, a proposition seemingly absurd, as being contrary to some received opinion; but yet true in fact. No science abounds more with paradoxes than geometry; thus, that a right line should continually approach to the hyperbola, and yet never reach it, is a true paradox; and in the same manner, a spiral may continually approach to a point, and yet not reach it, in any number of revolutions, however great.

PARAGOGE, in grammar, a figure whereby a letter or syllable is added to the end of a word; as *med*, for *me; dicier*, for *dici*, &c.

PARALLACTIC, in general, something relating to the parallax of heavenly bodies. See PARALLAX.

The parallactic angle, of a star, &c. is the difference of the angles C E A (Plate Parabola, &c. fig. 11) B T A, under which its true and apparent distance from the zenith is seen; or, which is the same thing, it is the angle T S E. The sines of the parallactic angle A L T, A S T (fig. 12) at the same or equal distances, Z S, from the zenith, are in the reciprocal ratio of the distances T L, and T S, from the centre of the earth.

PARALLAX, in astronomy, denotes a change of the apparent place of any heavenly body, caused by being seen from different points of view; or it is the difference between the true and apparent distance of any heavenly body from the zenith. Thus let A B (Plate XII. Miscell. fig. 1) be a quadrant of a great circle on the earth's surface, A the place of the spectator, and the point V, in the heavens, the vertex and zenith. Let V N H represent the starry firmament, A D the sensible horizon, in which suppose the star C to be seen, whose distance from the centre of the earth is T C. If this star were observed from the centre T, it would appear in the firmament in E, and elevated above the horizon by the arch D E; this point E is called the true place of the phenomenon or star. But an observer viewing it from the surface of

the earth at A, will see it at D, which is called its visible or apparent place; and the arch D E, the distance between the true and visible place, is what astronomers call the parallax of the star, or other phenomenon.

If the star rise higher above the horizon to M, its true place visible from the centre is P, and its apparent place N; whence its parallax will be the arch P N, which is less than the arch D E. The horizontal parallax, therefore, is the greatest; and the higher a star rises, the less is its parallax; and if it should come to the vertex or zenith, it would have no parallax at all; for when it is in Q, it is seen both from T and A in the same line TAV, and there is no difference between its true and apparent or visible place. Again, the further a star is distant from the earth, so much the less is its parallax; thus the parallax of the star F is only G I, which is less than D E the parallax of C. Hence it is plain, that the parallax is the difference of the distances of a star from the zenith, when seen from the centre and from the surface of the earth; for the true distance of the star M from the zenith is the arch V P, and its apparent distance V N, the difference between which P N is the parallax.

These distances are measured by the angles V T M, and V A M, but V A M — V T M = T M A. For the external angle V A M = angle A T M + angle A M T, the two inward and opposite angles; so that A M T measures the parallax, and upon that account is itself frequently called the parallax; and this is always the angle under which the semi-diameter of the earth A T, appears to an eye placed in the star; and therefore where the semi-diameter is seen directly, there the parallax is greatest, viz. in the horizon. When the star rises higher, the sine of the parallax is always to the sine of the star's distance from the zenith, as the semi diameter of the earth to the distance of the star from the earth's centre; hence if the parallax of a star be known at any one distance from the zenith, we can find its parallax at any other distance.

If we have the distance of a star from the earth, we can easily find its parallax; for on the triangle TAC, rectangular at A, having the semi-diameter of the earth, and T C the distance of the star, the angle A C T, which is the horizontal parallax, is found by trigonometry; and, on the other hand, if we have this parallax, we can find the distance of the star; since in the same triangle, having A T, and the angle A C T, the distance T C may be easily found.

Astronomers, therefore, have invented several methods for finding the parallaxes of stars, in order thereby to discover their distances from the earth. However, the fixed stars are so remote as to have no sensible parallax; and even the sun, and all the primary planets, except Mars and Venus when in perigee, are at so great distances from the earth, that their parallax is too small to be observed. In the moon, indeed, the parallax is found to be very considerable, which in the horizon amounts to a degree or more, and may be found thus: in an eclipse of the moon, observe when both its horns are in the same vertical circle, and at that instant take the altitudes of both horns: the difference of these two altitudes being halved and added to the least, or subtracted from the greatest, gives nearly the visible or apparent altitude of the moon's centre; and the true altitude is nearly equal to the altitude of the centre of the shadow at that time. Now we know the altitude of the shadow, because we know the place of the sun in the ecliptic, and its depression under the horizon, which is equal to the altitude of the opposite point of the ecliptic in which is the centre of the shadow. And therefore having both the true altitude of the moon and the apparent altitude, the difference of these is the parallax required. But as the parallax of the moon increases as she approaches towards the earth, or the perigæum of her orbit; therefore astronomers have made tables, which shew the horizontal parallax for every degree of its anomaly.

The parallax always diminishes the altitude of a phenomenon, or makes it appear lower than it would do, if viewed from the centre of the earth; and this change of the altitude may, according to the different situation of the ecliptic and equator in respect of the horizon of the spectator, cause a change of the latitude, longitude, declination and right ascension of any phenomenon, which is called their parallax. The parallax, therefore, increases the right and oblique ascension; diminishes the descension; diminishes the northern declination and latitude in the eastern part, and increases them in the western; but increases the southern both in the eastern and western part; diminishes the longitude in the western part, and increases it in the eastern. Hence it appears, that the parallax has just opposite effects to refraction. See REFRACTION.

Parallax, *annual*, the change of the apparent place of a heavenly body, which is caused by being viewed from the earth in different parts of its orbit round the sun. The annual parallax of all the planets is found very considerable, but that of the fixed stars is imperceptible.

Parallax, in levelling, denotes the angle contained between the line of the true level, and that of the apparent level.

PARALLEL. The subject of parallel lines, says Playfair, is one of the most difficult in the Elements of Geometry. It has accordingly been treated in a great variety of different ways, of which, perhaps, there is none which can be said to have given entire satisfaction. The difficulty consists in converting the twenty-seventh and twenty-eighth of Euclid, or in demonstrating, that parallel straight lines (or such as do not meet one another) when they meet a third line, make the alternate angles with it equal, or which comes to the same, are equally inclined to it, and make the exterior angle equal to the interior and opposite. In order to demonstrate this proposition, Euclid assumed it as an axiom, that if a straight line meet two straight lines, so as to make the interior angles on the same side of it less than two right angles, these straight lines being continually produced, will at length meet on the side on which the angles are that are less than two right angles. This proposition, however, is not self-evident; and ought the less to be received without proof, that the converse of it is a proposition that confessedly requires to be demonstrated. In order to remedy this defect, three sorts of methods have been adopted— a new definition of parallel lines; a new manner of reasoning on the properties of straight lines without any new axiom; and, the introduction of a new axiom less exceptionable than Euclid's. Playfair adopts the latter plan; but we do not perceive that his axiom is by any means self-evident upon Euclid's definition which he retains, viz. Parallel straight lines are such as are in the same plane, and which being produced ever so far both ways do not meet. A more intelligible, and we think an equally rigid, demonstration of the property of parallels, may be obtained without any axiom, by means of a new definition. It may at first sight be thought that the objection urged by Playfair against the definition in T. Simpson's first edition, must equally hold against ours; but we think that if his objection really hold good against that definition, (though we confess we cannot feel the force of it), it is obviated by distinguishing as ought to be done between the distance and the measure of that distance.

We must of course suppose our readers acquainted with the propositions in Euclid preceding the twenty-seventh; but to save the necessity of reference we shall give an enunciation of those which we shall have to employ in our demonstration, in the form in which we employ them. 1. (Prop. 16.) If one side of a triangle be produced, the outward angle is greater than either of the inward opposite angles. 2. (Prop. 19.) The greater angle of every triangle has the greater side opposite to it. 3. (Prop. 4.) If two triangles have two sides of the one respectively equal to two sides of the other, and have the included angles equal, the other angles will be respectively equal, *viz.* those to which the equal sides are opposite. 4. (Prop. 15.) If two straight lines cut each other, the vertical or opposite angles will be equal. 5. (Prop. 13.) If a straight line meet another, the sum of the adjacent angles is equal to the sum of two right angles.

6. *Definition.* Parallel straight lines are those whose least distances from each other are every where equal.

7. Theorem I. The perpendicular drawn to a straight line from any point, is the least line that can be drawn from that point to the given line.

Let C D, (Plate XII. Miscell. fig. 2) be a straight line drawn from C perpendicular to A B; and let C E be any other straight line from C to A B; then is C D less than C E. For the angle C D E equals angle C D A by construction; and C D A is greater than C E D (1); therefore C D E is greater than C E D. Hence (2) C D is less than C E.

8. Cor. 1. Hence the perpendicular from any point to a straight line is the true measure of the least distance of that point from that line.

9. Cor. 2. Hence (6) the perpendiculars to one of two parallel straight lines, from any points in the other, are every where equal to each other.

10. Cor. 3. Hence two parallel straight lines, however far they may be produced, can never meet.

11. Theorem II. If a line meeting two parallel straight lines be perpendicular to one of them, it is also perpendicular to the other.

If A B, (fig. 3) be parallel to C D, and E F meet them so as to be perpendicular to A B, it will also be perpendicular to C D. If not, draw E G perpendicular to C D and

from G draw G H perpendicular to A B. Then since E F and G H are both perpendicular to A B, and are drawn from F and G points in C D, G H equals E F (9). Again, since angle G H B or G H E is greater than angle G E H (1) E G is greater than G H (2). Hence E G is greater than E F. Therefore E G is not perpendicular to C D (7); and in the same manner it may be shown that no other line can be drawn from the point E perpendicular to C D without coinciding with E F. Therefore E F is perpendicular to C D.

12. Theorem III. If two straight lines be perpendicular to the same straight line, they are parallel to each other.

If A B, (fig. 4) and C D be both perpendicular to E F, then A B is parallel to C D. If A B be not parallel to C D, let G H passing through the point E, be parallel to C D. Then since E F is perpendicular to C D, it is also perpendicular to G H (11). Hence angle H E F is a right angle, and therefore equal to angle B E F, the less to the greater which is absurd. Therefore G H is not parallel to C D; and in the same manner it may be shown that no other line passing through E, and not coinciding with A B, is parallel to C D. Therefore A B is parallel to C D.

13. Cor. Hence it appears, that through the same point no more than one line can be drawn parallel to the same straight line.

It may be thought necessary to remark, that the preceding theorem pre-supposes the admission of a postulate, that through any point not in a given straight line, a straight line may be drawn parallel to that straight line, or that straight line produced.

14. Theorem IV. If a straight line fall upon two parallel straight lines, it makes the alternate angles equal to one another; and the exterior angle equal to the interior and opposite angle on the same side; and likewise, the two interior angles upon the same side, together, equal to two right angles.

If A B, (fig. 5) be parallel to C D, and E F cut them in the points H G, then the angle A H G equals the alternate angle H G D; the exterior angle E H B equals the interior and opposite angle on the same side H G D; and the two interior angles on the same side, B N G and H G D are together equal to two right angles. From H draw H K perpendicular to C D, and from G draw G I perpendicular to A B. Then since H K is perpendicular to C D, it is also perpendicular to A B (11); consequently G I is parallel to H K (12). But H I and G K are perpendiculars to G I, from H and K, points in H K; therefore (9) H I equals G K. Hence in triangles G I H, H G K, the side H I equals the side G K, G I equals H K (9) and the included angle G I H equals the included angle H K G; therefore angle I H G equals angle H G K (3). Again, angle E H B equals A H G (4); therefore it equals H G D. Lastly, B N G and H G D are together equal to A H G and B H G together; and therefore (5) are equal together to the sum of two right angles.

15. Theorem V. If a straight line falling upon two other straight lines makes the alternate angles equal to one another, those two straight lines will be parallel.

Let the straight line E F, (fig. 6) which falls upon the two straight lines A B, C D, make the alternate angles A E F, E F D equal to one another, then A B is parallel to C D. If not, through E draw G H parallel to C D. Then the alternate angle G E F equals the alternate angle E F D. But A E F equals E F D; therefore A E F is equal to G E F, the less to the greater. Hence G H is not parallel to C D; and in like manner it may be shown that no other line passing through the point E, and not coinciding with A B is parallel to C D. Therefore A B is parallel to C D.

16. Cor. If a straight line, falling upon two other straight lines, makes the exterior angle equal to the interior and opposite one on the same side of the line; or makes the interior angles on the same side equal to two right angles; the two straight lines shall be parallel to one another.

Parallel *planes*, are such planes as have all the perpendiculars drawn betwixt them equal to each other.

Parallel *rays*, in optics, are those which keep at an equal distance from the visible object to the eye, which is supposed to be infinitely remote from the object.

Parallel *ruler*, an instrument consisting of two wooden, brass, &c. rulers equally broad every where; and so joined together by the cross blades as to open to different intervals, accede and recede, and yet still retain their parallelism. See Pentagraph.

Parallels, or *parallel circles*, in geography, called also parallels, or circles of latitude, are lesser circles of the sphere conceived to be drawn from west to east, through all the points of the meridian, commencing from the equator to which they are

parallel, and terminating with the poles. They are called parallels of latitude, because all places lying under the same parallel, have the same latitude.

PARALLELS *of latitude*, in astronomy, are lesser circles of the sphere parallel to the ecliptic, imagined to pass through every degree and minute of the colures. They are represented on the globe by the divisions on the quadrant of altitude, in its motion round the globe, when screwed over the pole of the ecliptic. See GLOBE.

PARALLELS *of altitude*, or ALMUCANTARS, are circles parallel to the horizon, imagined to pass through every degree and minute of the meridian between the horizon and zenith, having their poles in the zenith. They are represented on the globe by the divisions on the quadrant of altitude, in its motion about the body of the globe, when screwed to the zenith.

PARALLELS *of declination*, in astronomy, are the same with parallels of latitude in geography.

PARALLEL *sphere*, that situation of the sphere, wherein the equator coincides with the horizon, and the poles with the zenith and nadir. In this sphere all the parallels of the equator become parallels of the horizon, consequently, no stars ever rise or set, but all turn round in circles parallel to the horizon; and the sun when in the equinoctial, wheels round the horizon the whole day. After his rising to the elevated pole, he never sets for six months; and after his entering again on the other side of the line, never rises for six months longer. This is the position of the sphere to such as live under the poles, and to whom the sun is never above 23° 30′ high.

PARALLEL *sailing*, in navigation, is the sailing under a parallel of latitude. See NAVIGATION.

PARALLELEPIPED, or PARALLELOPIPED, in geometry, a regular solid comprehended under six parallelograms, the opposite ones whereof are similar, parallel, and equal. All parallelepipeds, prisms, cylinders, &c. whose bases and heights are equal, are themselves equal. A diagonal plane divides a parallelepiped into two equal prisms; so that a triangular prism is half a parallelepiped upon the same base, and of the same altitude.

All parallelepipeds, prisms, cylinders, &c. are in a ratio compounded of their bases and altitudes; wherefore, if their bases be equal, they are in proportion to their altitudes, and conversely. All parallelepipeds, cylinders, cones, &c. are in a triplicate ratio, of their homologous sides, and also of their altitudes.

Equal parallelepipeds, prisms, cones, cylinders, &c. reciprocate their bases and altitudes.

PARALLELISM, the situation or quality whereby any thing is denominated parallel. See PARALLEL.

PARALLELISM *of the earth's axis*, in astronomy, that situation of the earth's axis, in its progress through its orbit, whereby it is still directed towards the pole-star; so that if a line be drawn parallel to its axis, while in any one position, the axis, in all other positions, will be always parallel to the same line.

This parallelism is the result of the earth's double motion, *viz.* round the sun, and round its own axis; or its annual and diurnal motion; and to it we owe the vicissitudes of seasons, and the inequality of day and night.

PARALLELISM *of the rows of trees*. These are never seen parallel, but always inclining to each other towards the further extreme. Hence mathematicians have taken occasion to inquire in what lines the trees must be disposed to correct this effect of the perspective, and make the rows still appear parallel. The two rows must be such, as that the unequal intervals of any two opposite or correspondent trees may be seen under equal visual rays.

PARALLELOGRAM, in geometry, a quadrilateral right-lined figure, whose opposite sides are parallel and equal to each other. It is generated by the equable motion of a right line always parallel to itself. When it has all its four angles right, and only its opposite sides equal, it is called a rectangle or oblong. When the angles are all right, and the sides equal, it is called a square. If all the sides are equal, and the angles unequal, it is called a rhombus or lozenge; and if the sides and angles be unequal, it is called a rhomboides.

In every parallelogram of what kind soever, a diagonal divides it into two equal parts; the angles diagonally opposite are equal; the opposite angles of the same side are together equal to two right angles; and each two sides, together, greater than the diagonal.

Two parallelograms on the same or equal base and of the same height, or between the same parallels, are equal; and hence two triangles on the same base and of the same height, are also equal. Hence,

also, every triangle is half a parallelogram upon the same or an equal base, and of the same altitude, or between the same parallels. Hence, also, a triangle is equal to a parallelogram, having the same base, and half the altitude, or half the base, and the same altitude.

Parallelograms, therefore, are in a given ratio compounded of their bases and altitudes. If then the altitudes be equal, they are as the bases, and conversely.

In similar parallelograms and triangles, the altitudes are proportional to the homologous sides, and the bases are cut proportionably thereby. Hence similar parallelograms and triangles are in a duplicate ratio of their homologous sides; as also of their altitudes, and the segments of their bases; they are, therefore, as the squares of the sides, altitudes, and homologous segments of the bases.

In every parallelogram, the sum of the squares of the two diagonals is equal to the sum of the squares of the four sides. For if the parallelogram be rectangular, it follows that the two diagonals are equal; and, consequently, the square of a diagonal, or, which comes to the same thing, the square of the hypothenuse of a right angle, is equal to the squares of the sides. See GEOMETRY.

PARALLELOGRAM, or PARALLELISM, a machine for the ready reduction of designs; it is the same with the PENTAGRAPH, which see.

PARAMETER, in conic sections, a constant line, otherwise called *latus rectum*. The parameter is said to be constant, because in the parabola, the rectangle under it and any abscis, is always equal to the square of the corresponding semi-ordinate; and in the ellipsis and hyperbola, it is a third proportional to the conjugate and transverse axis.

If t and c be the two axes in the ellipse and hyperbola, and x and y an abscis and its ordinate in the parabola: then

$t : c :: c : p = \frac{c^2}{t} =$ the parameter in the former;

$x : y :: y : p = \frac{y^2}{x} =$ the parameter in the last.

The parameter is equal to the double ordinate drawn through the focus of one of the three conic sections.

PARAMECIUM, in natural history, a genus of the Vermes Infusoria class and order. Worm invisible to the naked eye, simple, pellucid, flattened, oblong. There are seven species, of which P. aurelia is rather a large animalculum, membranaceous, pellucid, and about four times longer than it is broad; the fore-part obtuse, transparent, without intestines; the hind-part replete with molecules of various sizes; the fold which goes from the middle to the apex is a striking characteristic of the species, forming a kind of triangular aperture, and giving it somewhat the appearance of a gimblet. Its motion is rectilinear, reeling or staggering, and generally vehement. They are frequently found cohering lengthwise; the lateral edges of both bodies appear bright. They may also be seen sometimes lying on one another alternately, at others adhering by the middle. They will live many months in the same water without its being renewed. They are found in the beginning of summer, in those ditches in which duck-weed abounds. P. chrysalis is found plentifully in salt water.

PARAPET, in fortification, an elevation of earth designed for covering the soldiers from the enemies' cannon or small shot, The thickness of the parapet is from eighteen to twenty feet; its height is six feet on the inside, and four or five on the outside. It is raised on the rampart, and has a slope above called the superior talus, and sometimes the glacis of the parapet. The exterior talus of the parapet is the slope facing the country: there is a banquette or two for the soldiers who defend the parapet, to mount upon, that they may the better discover the country, fosse, and counterscarpe, and fire as they find occasion. Parapet of the covert-way, or corridor, is what covers that way from the sight of the enemy, which renders it the most dangerous place for the besiegers, because of the neighbourhood of the faces, flanks, and curtins of the place.

PARAPET is also a little wall raised breast high, on the banks of bridges, keys, or high buildings, to serve as a stay, and prevent people's falling over.

PARAPHRASE, an explanation of some text, in clearer and more ample terms, whereby is supplied what the author might have said or thought on the subject; such are esteemed Erasmus's Paraphrase on the New Testament, the Chaldee Paraphrase on the Pentateuch, &c.

PARASANG, an ancient Persian measure, different at different times, and in different places; being sometimes thirty,

sometimes forty, and sometimes fifty stadia, or furlongs.

PARASITES, or *Parasitical plants*, in botany, such plants as are supported by of the trunk or branches of other plants, from whence they receive their nourishment, and will not grow upon the ground, as the misletoe, &c.

PARCENERS, in law, persons holding lands in copartnership, and who may be compelled to make division. It occurs where lands descend to the females, who all take equal shares of their deceased father's lands.

PARCHMENT, in commerce, the skins of sheep or goats, prepared after such a manner as to render it proper for writing upon, covering books, &c. The manufacture of parchment is begun by the skinner, and finished by the parchment-maker. The skin, having been stripped of its wool, and placed in the lime-pit, in the manner described under the article SHAMMY, the skinner stretches it on a kind of frame, and pares off the flesh with an iron instrument; this done, it is moistened with a rag, and powdered chalk being spread over it, the skinner takes a large pumice-stone, flat at bottom, and rubs over the skin, and thus scowers off the flesh; he then goes over it again with the iron instrument, moistens it as before, and rubs it again with the pumice-stone without any chalk underneath: this smooths and softens the flesh-side very considerably. He then drains it again, by passing over it the iron instrument as before. The flesh-side being thus drained, by scraping off the moisture, he in the same manner passes the iron over the wool or hair side: then stretches it tight on a frame, and scrapes the flesh-side again: this finishes its draining; and the more it is drained, the whiter it becomes. The skinner now throws on more chalk, sweeping it over with a piece of lamb-skin that has the wool on, and this smooths it still further. It is now left to dry, and when dried, taken off the frame by cutting it all round. The skin, thus far prepared by the skinner, is taken out of his hands by the parchment-maker, who first, while it is dry, pares it on a summer, (which is a calf-skin stretched in a frame) with a sharper instrument than that used by the skinner, and working with the arm from the top to the bottom of the skin, takes away about one half of its thickness. The skin thus equally pared on the flesh-side, is again rendered smooth, by being rubbed with the pumice-stone, on a bench covered with a sack stuffed with flocks, which leaves the parchment in a condition fit for writing upon. The parings thus taken off the leather, are used in making glue, size, &c. See GLUE, &c. What is called vellum, is only parchment made of the skins of abortives, or at least, sucking calves. This has a much finer grain, and is whiter and smoother than parchment; but is prepared in the same manner, except its not being passed through the lime-pit.

PARDON, is the remitting or forgiving a felony or other offence committed against the King. Blackstone mentions the power of pardoning offences to be one of the greatest advantages of monarchy, in general, above every other form of government, and which cannot subsist in democracies. Its utility and necessity are defended by him on all those principles which do honour to human nature.

Pardons are either general or special: general, as by act of Parliament, of which, if they are without exceptions, the court must take notice, *ex officio*; but if there are exceptions therein, the party must aver, that he is none of the persons excepted: special pardons, are either of course, as to persons convicted of manslaughter, or *se defendendo*, and by several statutes, to those who shall discover their accomplices in several felonies; or of grace, which are by the King's charter, of which the court cannot take notice, *ex officio*, but they must be pleaded. A pardon may be conditional, that is, the King may extend his mercy upon what terms he pleases; and may annex to his bounty a condition, either precedent or subsequent, on the performance whereof, the validity of the pardon will depend; and this by the common law.

All pardons must be under the great seal. The effect of a pardon is to make the offender a new man; to acquit him of all corporal penalties and forfeitures annexed to that offence, and to give him a new credit and capacity; but nothing but an act of Parliament can restore or purify the blood after an attainder.

PAREGORICS, medicines that assuage pain, otherwise called anodynes. See PHARMACY.

PARENCHYMA *of plants*. Grew applies the term parenchyma to the pith or pulp, or that inner part of a fruit or plant through which the juice is supposed to be distributed. This, when viewed with a microscope, appears to resemble marrow, or rather a sponge, being a porous, flexible,

dilatable substance. Its pores are innumerable and exceedingly small, receiving as much humour as is requisite to fill and extend them, which disposition of pores it is that is supposed to fit the plant for vegetation and growth.

PARENTS and CHILDREN, in law. If parents run away, and leave their children at the charge of the parish, the churchwardens and overseers, by order of the justices, may seize the rents, goods, and chattels of such persons, and dispose thereof towards their children's maintenance. A parent may lawfully correct his child, being under age, in a reasonable manner; but the legal power of the father over the persons of his children ceases at the age of twenty-one.

PARENTHESIS, in grammar, certain intercalary words, inserted in a discourse, which interrupt the sense, or thread, but seem necessary for the better understanding of the subject. The proper characteristic of a parenthesis is, that it may be either taken in or left out, the sense and the grammar remaining entire. In speaking, the parenthesis is to be pronounced in a different tone; and in writing, it is enclosed between ( ), called also a parenthesis, but commonly a bracket, or crotchet, to distinguish it from the rest of the discourse. The politest of our modern writers avoid all parenthesis, as keeping the mind in suspense, embarrassing it, and rendering the discourse less clear, uniform, and agreeable.

PARHELIUM, or PARHELION, in physiology, a mock sun, or meteor, in form of a very bright light, appearing on one side of the sun. The parhelia are formed by the reflection of the sun's beams on a cloud properly posited. They usually accompany the coronæ, or luminous circles, and are placed in the same circumference, and at the same height. Their colours resemble that of the rainbow, the red and yellow are on the side towards the sun, and the blue and violet on the other. There are coronæ sometimes seen without parhelia, and *vice versa*. Parhelia are double, triple, &c. and in 1629, a parhelion of five suns was seen at Rome; and in 1666, another at Arles of six. M. Mariotte accounts for parhelia from an infinity of little particles of ice floating in the air, that multiply the image of the sun by refraction or reflection; and by a geometrical calculus he has determined the precise figure of these little icicles, their situation in the air, and the size of the coronæ of circles which accompany the parhelia, and the colours wherewith they are painted. M. Huygens accounts for the formation of a parhelion in the same manner as for that of the halo.

PARIAN *chronicle*. See ARUNDELIAN *marbles*.

PARIANA, in botany, a genus of the Monoecia Polyandria class and order. Essential character: male, flowers in whorls, forming spikes; calyx two-valved; corolla two-valved, larger than the calyx; filaments forty: female, flowers solitary in each whorl; calyx two-valved; corolla two-valved, less than the calyx; stigmas two; seed three-cornered, inclosed. There is but one species, *viz.* P. campestris, a native of the woods in the island of Cayenne.

PARIETARIA, in botany, *pellitory*, a genus of the Polygamia Monoecia class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: two hermaphrodite flowers, and one female flower in a flat six-leaved involucre; calyx four-cleft; corolla none; style one; seed one, superior, elongated: hermaphrodite, stamina four: female, stamina none. There are ten species.

PARIS, in botany, a genus of the Octandria Tetragynia class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx four-leaved; petals four, narrower; berry four-celled. There is but one species, *viz.* P. quadrifolia, herb Paris, true-love, or one-berry.

PARISH, signifies the precinct of a parish church, and the particular charge of a secular priest. Formerly a parish was synonymous with diocese, and the tythes were paid to any priest whom the party chose, but it was found convenient to allot a certain district for each priest, that he alone might receive the tythe. It is very doubtful when they originated. Some place the division of parishes in A. D. 630, others in 1179. A parish may contain one or more vills, but it is presumed to contain only one, and anciently was co-extensive with the manor. Money given by will to a parish is given to the poor. These districts are computed to be nearly ten thousand in number.

PARISH *clerk*. In every parish the parson, vicar, &c. hath a parish clerk under him, who is the lowest officer of the church. These were formerly clerks in orders, and their business at first was to officiate at the altar, for which they had a competent maintenance by offerings; but now they are laymen, and have certain fees with the par-

son on christenings, marriages, burials, &c. besides wages for their maintenance. He must be twenty years of age, and of honest conversation, and is generally appointed by the minister, unless there is a custom for the churchwardens and parishioners to elect. It is an office for life, and a freehold. He may make a deputy without licence of the bishop.

PARISHIONER, an inhabitant of, or belonging to, any parish, lawfully settled there. Parishioners are a body politic to many purposes; as to vote at a vestry if they pay scot and lot, and they have a sole right to raise taxes for their own relief, without the interposition of any superior court; may make by-laws to mend the highways, and to make banks to keep out the sea, and for repairing the church, and making a bridge; and for making and maintaining fire engines. They may also purchase workhouses for the poor, or any such thing for the public good.

PARKINSONIA, in botany, so named in memory of John Parkinson, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-cleft; petals five, ovate, the lowest kidney-form; style none; legume necklace form. There is but one species, viz. P. aculeata, prickly Parkinsonia. It is a native of Jamaica, where it is called Jerusalem thorn.

PARLIAMENT. The parliament is the legislative branch of the supreme power of Great Britain, consisting of the King, the Lords spiritual and temporal, and the Knights, Citizens, and Burgesses, representatives of the Commons of the Realm, in Parliament assembled.

The power and jurisdiction of Parliament is so transcendent and absolute, that it cannot be confined, either for causes or persons, within any bounds.

The Parliament must be summoned by the King, and not by authority of either house, at least forty days before it sits, although the Convention Parliament (the House of Commons), from necessity, was summoned by the Keepers of the Liberty of England, by authority of Parliament. It cannot begin without the King in person, or by representation. The principal privileges of Parliament are the privilege of speech, which is essential to its existence, and to which there are no exceptions, except in some precedents of information filed for using free language during the reign of the second Charles, which it is to be hoped will never be drawn into authority, and the privilege of person from arrest and imprisonment for debt. This privilege lasts for forty days after the prorogation of the Parliament, and forty days previous to its meeting. But all other privileges derogating from the common laws and matters of civil right, are abolished by several statutes; and by 4 George III. c. 33, a trader, being a Member of Parliament, may be served with legal process for any just debt to the amount of one hundred pounds, and unless he makes satisfaction within two months, it shall be an act of bankruptcy. Vide statutes 12 William III. c. 3; 2 and 3 Ann, c. 18; 11 George II. c. 24. Statute 10 George III. c. 50; 4 George III. c. 33.

It is one of the privileges of the Peers to be entitled to vote by proxy, and also to enter a protest against any bill to which they may dissent. But all money bills must commence with the Commons; and it is now the custom, if any alteration is made by the Lords in a money bill, for the Commons to reject it and bring in another, even though the new bill should contain the regulation proposed by the Lords.

The House of Commons is a denomination given to the lower house of Parliament. In a free state, every man who is supposed a free agent, ought to be in some measure his own governor, and therefore a branch at least of the legislative power should reside in the whole body of the people. In elections for representatives for Great Britain, anciently, all the people had votes; but King Henry VI. to avoid tumults, first appointed that none should vote for knights but such as were freeholders, did reside in the county, and had forty shillings yearly revenue. In so large a state as ours, therefore, it is very wisely contrived that the people should do that by their representatives, which it is impracticable to perform in person; representatives chosen by a number of minute and separate districts, wherein all the voters, or may be, easily distinguished. The counties are therefore represented by knights, elected by the proprietors of lands, the cities and boroughs are represented by citizens and burgesses, chosen by the mercantile, or supposed trading interest of the nation.

The peculiar laws and customs of the House of Commons, relate principally to the raising of taxes, and the elections of members to serve in Parliament.

The method of making laws is nearly the same in both houses. In the House of Commons, in order to bring in the bill, if the relief sought be of a private nature, it is first necessary to prefer a petition, which must be presented by a member, and usually set forth a grievance required to be remedied. This petition, when founded on facts of a disputable nature, is referred to a committee of members, who examine the matter alleged, and accordingly report it to the house; and then (or otherwise upon the mere petition), leave is given to bring in the bill. In public matters, the bill is brought in upon motion made to the house, without any petition. If the bill begin in the House of Lords, if of a private nature, it is referred to two judges, to make report. After the second reading, the bill is said to be committed, that is, referred to a committee, which is selected by the house, in matters of small importance; or, upon a bill of consequence, the house resolves itself into a committee of the whole house: a committee of the whole house is composed of every member, and to form it the Speaker quits the chair and may consequently sit and debate upon the merits of it as a private member, another member being appointed chairman for the time. In these committees the bill is usually debated clause by clause, amendments made, and sometimes it is entirely new modelled. Upon the third reading, further amendments are sometimes made, and if a new clause be added, it is done by tacking a separate piece of parchment on the bill, which is called a rider. The royal assent may be given two ways. 1. In person, when the King comes to the House of Peers, in his crown and royal robes, and sending for the Commons to the bar, the titles of all the bills that have passed both houses are read, and the King's answer is declared by the clerk of the Parliament. If the King consent to a public bill, the clerk usually declares, *le Roy le veut*, the King wills it so to be; if to a private bill, *soit fait comme il est desire*, be it as it is desired. If the King refuse his assent, it is in the gentle language of *le Roy s'avisera*, the King will advise upon it. When a bill of supply is passed, it is carried up and presented to the King by the Speaker of the House of Commons, and the royal assent is thus expressed, *le Roy remercie ses loyal sujets, accepte leur benevolence, et aussi le veut*, the King thanks his loyal subjects, accepts their benevolence, and also wills it so to be. By the statute 33 Henry VIII. c. 21, the King may give his assent by letters patent under his great seal, signed with his hand, and notified in his absence to both houses assembled together in the upper house. And when the bill has received the royal assent in either of these ways, it is then, and not before, a statute or act of parliament.

An act of parliament thus made, is the exercise of the highest authority that this kingdom acknowledges upon the earth. It has power to bind every subject in the land, and the dominions thereunto belonging; nay even the King himself if particularly named therein. And it cannot be altered, amended, dispensed with, suspended, or repealed, but in the same forms, and by the same authority of Parliament.

Adjournment is no more than a continuance of the session from one day to another, as the word itself signifies; and this is done by the authority of each house separately every day, or for a longer period; but the adjournment of one house, is no adjournment of the other.

Prorogation, is the continuance of the Parliament from one sessions to another, as an adjournment is a continuation of the session from day to day. And this is done by the royal authority, expressed either by the Lord Chancellor, in his Majesty's presence, or by commission from the crown, or frequently by proclamation; and by this, both houses are prorogued at the same time; it not being a prorogation of the House of Lords or Commons, but of the Parliament. The session is never understood to be at an end, until a prorogation; though, unless some act be passed, or some judgment given in Parliament, it is, in truth, no session at all.

A dissolution is the civil death of the Parliament; and this may be effected three ways; 1. by the King's will, expressed either in person or representation; 2. by the demise of the crown; 3. by length of time. By the King's will; for as the King hath the sole right of convening the Parliament, so also it is a branch of the royal prerogative, that he may, whenever he pleases, prorogue the Parliament for a time, or put a final period to its existence.

By the demise of the crown; a dissolution formerly happened immediately upon the death of the reigning sovereign; but the calling a new Parliament immediately on the inauguration of the successor being found inconvenient, and dangers being apprehended from having no Parliament in being, in case of a disputed succession; it

was enacted by statutes 7 and 8 Will. III. c. 15, and 6 Anne, c. 7, that the Parliament in being, shall continue for six months after the death of any King or Queen, unless sooner prorogued or dissolved by the successor. That if the Parliament be, at the time of the King's death, separated by adjournment or prorogation, it shall notwithstanding assemble immediately; and that if no Parliament is then in being, the members of the last Parliament shall assemble and be again in Parliament. Lastly, a Parliament may be dissolved or expire by length of time.

The utmost extent of time that the same Parliament was allowed to sit by the statute of 6 William, c. 3, was three years; after the expiration of which, reckoning from the return of the first summons, the Parliament was to have no longer continuance. But by statute 1 George I. c. 38, in order, as it was alleged, to prevent the great and continued expenses of frequent elections, and the violent heats and animosities consequent thereupon, and for the peace and security of the government just then recovering from the last rebellion, this term was prolonged to seven years. So that as our constitution now stands, the Parliament must expire, or die a natural death, at the end of every seventh year, if not sooner dissolved by the royal prerogative. In favour of liberty, however, it were much to be wished that this statute had never been passed. The pretexts which it assigns, as the grounds upon which it was passed, are all fallacious.

Parliament, *the High Court of*, is the supreme court of the kingdom, not only for the making, but also for the execution of laws, by the trial of great and enormous offenders, whether lords or commoners, in the method of parliamentary impeachment. An impeachment before the Lords, by the Commons of Great Britain in Parliament, is a prosecution of the already known and established law, and has been frequently put in practice; being a presentment to the most high and supreme court of criminal jurisdiction, by the most solemn grand inquest of the whole kingdom. A commoner cannot, however, be impeached before the Lords for any capital offence, but only for high misdemeanors; a peer may be impeached for any crime. And they usually, in case of an impeachment of a peer for treason, address the crown to appoint a lord high steward, for the greater dignity and regularity of their proceedings; which high steward was formerly elected by the peers themselves, though he was generally commissioned by the king; but it has of late years been strenuously maintained, that the appointment of a high steward in such cases is not indispensably necessary; but the house may proceed without one. The articles of impeachment are a kind of bills of indictment, found by the House of Commons, and afterwards tried by the Lords; who are in cases of misdemeanors considered not only as their own peers, but as the peers of the whole nation.

Much has been said and written upon the question of parliamentary reform, and the actual state of the Parliament. The result of a candid inquiry will be this; namely, that the Parliament, which has been, and now is the guardian of the liberties of the people, may hereafter by corruption become the means of their destruction, or the cause of their being surrendered, and the Parliament itself have only a nominal existence. To prevent this, the people can only depend upon the frequent necessity of their representatives appealing to them for a renewal of their powers; that is, upon the frequency of elections, which in order also to be free should be made by as large a body of voters as possible, and that what are called rotten boroughs should at once be abolished. To object to this, that it is an infringement of chartered rights, is an insult to common sense; for all charters are void that are against common right, and the only object of elections is for the benefit of the many, not for the private advantage of the few. That the present state of the representation of the people is not such as it ought to be has been too generally admitted to be insisted upon here; but let it never be forgotten, that amongst those who have considered it as defective we must number Mr. Pitt, Mr. Fox, and the commentator Blackstone. In any future revision of the laws against bribery and corruption, it would be well to make the elected as well as the electors take the oath against bribery; and still further to narrow, though not wholly to exclude, the admission of placemen and contractors to seats in the House of Commons. If the freedom of the press can be fully preserved, or obtained, we may venture to hope that every thing will ultimately be effected which the rational friends of freedom can desire; but a knowledge of our history will teach us, that little is to be gained for liberty by adherence to any precedents drawn from proceedings be-

fore the Revolution, the true principles of which are the only genuine grounds on which to rest the foundation of British liberty.

PARNASSIA, in botany, a genus of the Pentandria Tetragynia class and order. Natural order of Capparides, Jussieu. Essential character: calyx five-parted; petals five; nectaries five, cordate, ciliate, with globular apexes; capsule four-valved. There is but one species, *viz.* P. palustris, common marsh parnassia, or grass of Parnassus.

PARODICAL *degrees of an equation*, in algebra, are the several regular terms in quadratic, cubic, biquadratic equations, &c. the indexes of whose powers ascend or descend orderly in an arithmetical progress, as $z^3 + z^2 m + z r = s$, is a cubical equation, where no term is wanting, but having all its parodic degrees, the indexes of the terms regularly descending.

PARODY, a popular maxim, adage, or proverb. Parody is also a poetical pleasantry, consisting in applying the verses written on one subject, by way of ridicule to another; or in turning a serious work into a burlesque, by affecting to observe, as nearly as possible, the same rhymes, words, and cadences. It comes nearly to what some of our late writers call travesty; and was first set on foot by the Greeks, from whom we borrow the name.

PAROLE, a term signifying any thing done verbally or by word of mouth, in contradistinction to what is written: thus, an agreement may be by parole. Evidence also may be divided into parole evidence and written evidence. A parole release is good to discharge a debt by simple contract. The holder of a bill of exchange may authorise another to indorse his name upon it by parole; and generally all agreements by parole are good, except such as are within the statute of frauds, and particularly such as relate to lands, and agreements for any term beyond three years in lands or houses, and also all executory agreements for the sale of goods above 10*l.* not forfeited by delivery. See AGREEMENT and LEASE.

PARRA, the *jacana*, in natural history, a genus of birds of the order Grallæ. Generic character: bill slender and sharply pointed, the base carunculated; nostrils in the middle, and somewhat oval; wings spinous; toes four, very long, and claws sharply pointed and long. There are sixteen species mentioned by Gmelin. Latham notices nine.

P. jacana, or the chesnut jacana, is the size of the water rail, frequents the watery places of South America, and is extremely clamorous. These birds often wade up to the thighs in water, are particularly shy, scarcely ever seen but in pairs, and when separated, incessantly calling for each other till a reunion is accomplished. They are called by the French chirurgiens. Their flesh is valued.

P. chavaria is as large as a dunghill cock, with legs extremely long and strong, and toes so lengthened as to entangle in each other in its walking, on which account its usual movement on the ground is slow, and without the assistance of its wings it is incapable of running. Its flight, however, is rapid, and it is able to swim with ease. Its principal residence is about Carthagena in South America, where it is usual for the breeders of poultry to keep one of these birds tame, which attend their flocks as centinel, and effectually secures them from birds of prey. Its immense spurs are dreaded and avoided, even by the vulture. It is said to feed on vegetables.

PARROT. See PSITTACUS.

PARSON, signifies the rector of a church. He is in himself a body corporate, in order to protect and defend the rights of the church by a perpetual succession. When a parson is instituted and inducted into a rectory, he is then, and not before, in full and complete possession. A parson has regularly during life the freehold in himself of the parsonage-house, the glebe or land annexed to the parsonage, and the tythes and other dues; but these are sometimes in the hands of an appropriator, and then there is a vicar, who is endowed with a portion of the glebe and of the tythes.

PARTS *of speech*, in grammar, are all the sorts of words which enter the composition of discourse.

The grammarians generally admit of eight parts of speech, *viz.* noun, pronoun, verb, participle, adverb, preposition, interjection, and conjunction. See GRAMMAR.

PARTHENIUM, in botany, a genus of the Monoecia Pentandria class and order. Natural order of Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: male, calyx common five-leaved; corolla of the disk one-petalled: female, corolla of the ray five; on each side two males, with one female between, superior. There are two species, *viz.* P. hysterophorus, cut-leaved parthenium, or bastard feverfew, and P. integrifolium, entire-leaved parthenium;

the former is an annual plant, growing naturally in Jamaica, where it is called wild wormwood; it thrives very luxuriantly in the low lands; it is observed to possess similar qualities with feverfew; it flowers here in July and August.

PARTI, PARTIE, PARTY, or PARTED, in heraldry, is applied to a shield or escutcheon, denoting it divided or marked out into partitions.

The French heralds, from whom we borrow the word, have but one kind of parti, the same with our parti per pale, which they simply call parti; but with us the word is applied to all sorts of partitioning, and is never used without some addition, to specify the particular kind intended: thus we have parti, or parted, per cross, per chief, per pale, per fess, per bend dexter, per bend sinister, per chevron, &c.

PARTICIPLE. See GRAMMAR.

PARTICLE, in physiology, the minute part of a body, an assemblage of which constitute all natural bodies. See ATOMICAL *philosophy*.

It is the various arrangement and texture of these particles, with the difference of cohesion, &c. that constitute the various kinds of bodies. The smallest particles cohere with the strongest attraction, and compose bigger particles of weaker cohesion, and many of these cohering compose bigger particles, whose vigour is still weaker; and hereupon the operations in chemistry, and the colours of natural bodies depend, and which, by cohering, compose bodies of sensible bulk. The cohesion of the particles of matter, the Epicureans imagined, was effected by the means of hooked atoms; the Aristotelians, by rest; but Sir Isaac Newton shews, that it is done by means of a certain power, whereby the particles mutually attract and tend towards each other. By this attraction of the particles, he shews that most of the phenomena of the lesser bodies are affected, as those of the heavenly bodies are, by the attraction of gravity.

In investigating the actions exerted between minute particles of matter, we must distinguish them as acted upon by the force of aggregation, or the force of chemical affinity: hence the distinction between the integrant and constituent particles of bodies. The constituent parts are substances differing in their nature from each other, and from the substance which they form. The integrant parts are precisely similar to each other, and to the general mass which is composed by their union, or, in other words, they are the smallest particles into which a substance can be resolved without decomposition; while decomposition is always implied in the division of a body into its constituent particles. The integrant parts are united by the force of aggregation, the constituent parts by chemical affinity. Hence chemists say that simple bodies consist entirely of integrant parts, all their particles being alike in their properties. But compounds may be considered as consisting both of integrant and constituent parts; and it has been supposed, that when an attraction is exerted between two compound substances, it is between their integrant parts, not their constituent principles, and that it is the combination of the former which constitutes the substance formed by their union.

PARTICLE, in grammar, a denomination for all those small words that tie or unite others together, or that express the modes or manners of words, usually included by grammarians under these four parts of speech, viz. adverbs, prepositions, interjections, and conjunctions.

PARTIES, are those which are named in a deed or fine, as parties to it. See FINE.

PARTITION, is a dividing of lands descended by the common law or custom, among coheirs or parceners, where there are two at the least.

PARTITION, in music, the disposition of the several parts of a song set on the same leaf, so as upon the uppermost ranges of lines are found the treble; in another, the bass; in another, the tenor, &c. that they may be all sung or played, either jointly or separately.

PARTNERSHIP, in arithmetic. See FELLOWSHIP.

PART-OWNERS, are partners interested and possessed of certain shares in a ship. Owners are tenants in common with each other; but one or more joint-owners refusing to contribute their quota to the outfit of the vessel, cannot prevent her from going to sea against the consent of the majority of the owners, who, giving security in the Admiralty, may freight the ship at their own exclusive risk, by which the smaller dissentient number of owners will be excluded at once from any share, either in the risk or in the profits. See SHIPPING.

PARTRIDGE. See TETRAO.

PARUS, the titmouse, in natural history,

a genus of birds of the order Passeres. Generic character: bill strait, somewhat compressed, strong, hard, and pointed; nostrils round, and covered with bristles turned back over them from the base of the bill; tongue truncated, and bristly at the end; toes divided to their origin, the back one very large and strong. These birds are found in almost every part of the old Continent, from the north of Europe to the south of India, and are highly prolific, laying eighteen or twenty eggs, which they hatch with unwearied patience. They build their nest with particular neatness and skill, and frequently on the extremity of some branch suspended over water, by which they secure it from the attack of various animals to which it might otherwise fall a prey. They are wonderfully active and alert, rapid and assiduous in their search for insects, on which they principally subsist, under the bark and in the crevices of trees, which they clear of the immense multitudes of caterpillars covering them in spring, and which would totally blast their vegetation. They are in no country migratory, though they occasionally change their residence for short distances. They are impassioned and irascible to a great degree, and when irritated will display that ardent eye and muffled plumage which indicate the paroxysm of agitation. Their courage is of the first order, as they are known sometimes to attack birds three times their size. Even the owl is by no means secure from their rage, and whatever bird they pursue, their first attempts are levelled at the head, and particularly at the eyes and brains, the latter of which they eat with particular avidity and relish. Gmelin enumerates thirty-one species, and Latham twenty-seven.

P. major, or the greater titmouse, weighs about an ounce. The male and female associate for some time before they begin to build, which they do with the most downy materials, and generally in the hole of some tree. The young continue blind for several days, and after they have left the nest never return to it, but continue, however, in the same neighbourhood, with the appearance of great family attachment, till the ensuing spring. See Aves, Plate X. fig. 7.

P. cæruleus, or the blue titmouse, is eminently beautiful, and highly serviceable in destroying caterpillars in orchards and gardens. It picks the bones of small birds to the most complete cleanness, and is distinguished by the bitterness of its aversion to the owl. See Aves, Plate X. fig. 8.

P. caudatus, or the long-tailed titmouse, lives in the same manner as the former, and has the same general habits with the rest of the genus, but builds its nest with peculiar care and elegance, securing, in the completest manner, the two important circumstances of dryness and warmth; the silken threads of aurelias constitute a principal article for those purposes. It is active even to restlessness, perpetually flying backwards and forwards, and running up and down the branches of trees in every possible direction. It possesses all the fullness of plumage of the owl.

PASCAL (Blaise), a respectable French mathematician and philosopher, and one of the greatest geniuses and best writers that country has produced. He was born at Clermont in Auvergne, in the year 1623. His father, Stephen Pascal, was president of the Court of Aids in his province: he was also a very learned man, an able mathematician, and a friend of Des Cartes. Having an extraordinary tenderness for this child, his only son, he quitted his province, and settled at Paris in 1631, that he might be quite at leisure to attend to his son's education, which he conducted himself, and young Pascal never had any other master. From his infancy Blaise gave proofs of a very extraordinary capacity. He was extremely inquisitive; desiring to know the reason of every thing; and when good reasons were not given him, he would seek for better; nor would he ever yield his assent but upon such as appeared to him well grounded. What is told of his manner of learning the mathematics, as well as the progress he quickly made in that science, seems almost miraculous. His father, perceiving in him an extraordinary inclination to reasoning, was afraid lest the knowledge of the mathematics might hinder his learning the languages, so necessary as a foundation to all sound learning. He therefore kept him as much as he could from all notions of geometry, locked up all his books of that kind, and refrained even from speaking of it in his presence. He could not however prevent his son from musing on that science; and one day in particular he surprised him at work with charcoal upon his chamber floor, and in the midst of figures. The father asked him what he was doing: I am searching, says Pascal, for such a thing; which was just the same as the 32d proposition of the 1st book of Euclid. He

asked him then how he came to think of this: it was, said Blaise, because I found out such another thing; and so, going backward, and using the names of *bar* and *round*, he came at length to the definitions and axioms he had formed to himself. From this time he had full liberty to indulge his genius in mathematical pursuits. He understood Euclid's Elements as soon as he cast his eyes upon them. At sixteen years of age he wrote a treatise on Conic Sections, which was accounted a great effort of genius; and therefore it is no wonder that Des Cartes, who had been in Holland a long time, upon reading it, should choose to believe that M. Pascal the father was the real author of it. At nineteen he contrived an admirable arithmetical machine, which would have done credit as an invention to any man versed in science. About this time his health became impaired, so that he was obliged to suspend his labours for the space of four years. After this, having seen Torricelli's experiment respecting a vacuum and the weight of the air, he turned his thoughts towards these objects, and undertook several new experiments, by which he was fully convinced of the general pressure of the atmosphere; and from this discovery he drew many useful and important inferences. He composed also a large treatise, in which he fully explained this subject, and replied to all the objections that had been started against it. As he afterwards thought this work rather too prolix, and being fond of brevity and precision, he divided it into two small treatises, one of which he entitled, "A Dissertation on the Equilibrium of Fluids;" and the other, "An Essay on the Weight of the Atmosphere." These labours procured Pascal so much reputation, that the greatest mathematicians and philosophers of the age proposed various questions to him, and consulted him respecting such difficulties as they could not resolve. Upon one of these occasions he discovered the solution of a problem proposed by Mersenne, which had baffled the penetration of all that had attempted it. This problem was to determine the curve described in the air by the nail of a coach-wheel, while the machine is in motion; which curve was thence called a roulette, but now commonly known by the name of cycloid. Pascal offered a reward of forty pistoles to any one who should give a satisfactory answer to it. No person having succeeded, he published his own at Paris; but under the name of A. d'Ettonville. This was the last work which he published in the mathematics; his infirmities, from a delicate consitution, though still young, now increasing so much, that he was under the necessity of renouncing severe study, and of living so recluse, that he scarcely admitted any person to see him.

After having thus laboured abundantly in mathematical and philosophical disquisitions, he forsook those studies and all human learning at once, to devote himself to acts of devotion and penance. He was not twenty-four years of age, when the reading some pious books had put him upon taking this resolution; and he became as great a devotee as any age has produced. He now gave himself up entirely to a state of prayer and mortification; and he had always in his thoughts these great maxims of renouncing all pleasure and all superfluity; and this he practised with rigour even in his illnesses, to which he was frequently subject, being of a very invalid habit of body. He died at the age of thirty-nine. His works were collated and published at the Hague in five volumes 8vo, by the Abbé Bossu, 1779.

PASCAL *rents*, rents or annual duties paid by the inferior clergy to the bishop or archdeacon, at their Easter visitation.

PASPALUM, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, orbicular; corolla of the same size; stigmas pencilled. There are fifteen species. All these grasses are of foreign growth, none of them natives of Europe.

PASSAGE. In stat. 4 Edward III. c. 7, this term is used for the hire a man pays for being transported over any sea or river. Various statutes of a local nature have been passed for regulating the passage of particular rivers. By a statute of Edward IV. the passage from Kent to Calais is restrained to Dover.

PASSAGE, *birds of*, a name given to those birds which at certain stated seasons of the year remove from certain countries, and at other stated times return to them again, as our quails, woodcocks, storks, nightingales, swallows, and many other species. The generality of birds that remain with us all the winter have strong bills, and are enabled to feed on what they can find at that season; those which leave us, have usually very slender bills, and their food is the insects of the fly kind, which disappearing towards the approach of winter,

compel them to seek them in the warmer regions where they are to be found. Among the birds of passage, the fieldfare, the red-wing, the woodcock, and the snipe, come to us in the autumn, at the time when the summer birds are leaving us, and go from us again in spring, at the time when these return; and of these the two last often continue with us through the summer, and breed; so that the two first seem the only kinds that certainly leave us at the approach of spring, retiring to the northern parts of the continent, where they live during the summer, and breed; and, at the return of winter, are driven southerly from those frigid climes, in search of food, which there the ice and snow must deprive them of.

PASSAGE, *right of*, in commerce, is an imposition or duty exacted by some princes, either by land or sea, in certain close and narrow places in their territories, on all vessels and carriages, and even sometimes on persons or passengers coming in or going out of ports, &c. The most celebrated passage of this kind in Europe is the Sound, the dues for passing which straight belong to the King of Denmark, and are paid at Elsenore or Croneuburg.

PASSANT, in heraldry, a term applied to a lion, or other animal, in a shield, appearing to walk leisurely: for most beasts, except lions, the term trippant is frequently used instead of passant.

PASSERES, in natural history, the sixth order of birds according to the Linnæan system, they are distinguished by a conical and pointed bill; nostrils oval, pervious, naked; legs formed for hopping; toes slender, divided; body slender, flesh of such as feed on grain pure; of those which feed on insects impure; nest formed with much art. They live chiefly in trees and hedges, are monogamous, vocal, and feed the young by thrusting the food down their throats. They are thus divided: the genera in A have thick bills, as the

Colius	Loxia
Emberiza	Phitoloma.
Fringilla	

Those in B have the upper mandible somewhat hooked at the point: as the

Caprimulgus	Hirundo
Pipra.	

Those in C have the upper mandible notched near the end: as the

Ampelis	Tanagra
Muscicapa	Turdus.

Those in D have the bill straight, simple, tapering: as the

Alauda	Parus
Columba	Sturnus.
Motacilla	

PASSERINA, in botany, *sparrow-wort*, a genus of the Octandria Monogynia class and order. Natural order of Veprecula. Thymelææ, Jussieu. Essential character: calyx none; corolla four-cleft; stamina placed on the tube; seed one, corticate. There are nineteen species, chiefly natives of the Cape of Good Hope and New Zealand.

PASSIFLORA, in botany, *passion flower*, a genus of the Gynandria Pentandria class and order. Natural order of Cucurbitaceæ. Essential character: styles three; calyx five-leaved; petals five; nectary a crown; berry pedicelled. There are thirty-seven species, of which we shall notice the P. cærulea, common or blue passion flower. This tree rises in a few years to a great height, with proper support, the shoots often growing to the length of ten or twelve feet in one summer; at each joint is one leaf, composed of five smooth entire lobes; their footstalks are nearly two inches long, having two embracing stipules at their base; from the same point issues a long clasper, or tendril, the flowers come out at the same joint with the leaves, on peduncles three inches long; they have a faint scent, lasting only one day; fruit egg-shaped, the size and shape of the Mogul plum, when ripe of the same yellow colour, inclosing a sweetish disagreeable pulp, in which are lodged oblong seeds. The blue passion flower grows naturally in Brazil. It is now become the most common species in England, being sufficiently hardy to thrive in the open air.

These beautiful plants were unknown till the discovery of America; they are found in various parts, both of the continent, chiefly of South America, and the islands.

PASSION, or *the Passions*. The latter term serves to express those sensations of the soul excited by pleasure and pain; which two principal feelings are divided into a variety of branches, and those we shall endeavour, in the succeeding pages, to explain, as far as our limited powers will permit.

The passions are, in a great degree, selfish; and yet, fortunately for the general benefit of the human race, they are far from being entirely so.

Fear may be said to be entirely confined

to self-love in many instances, but this passion is frequently extended in a secondary state to an apprehension for the well-being of others in whose happiness we feel deeply interested; and yet it may admit of doubt whether the idea of being deprived of some previously experienced pleasure may not influence and promote our apparently disinterested affection. Indeed there are philosophers who attribute all our passions and actions to the sole motive of self-love, though we hope and trust erroneously.

Various theories have been published, by which their authors have endeavoured to elucidate the manner in which the passions are excited in and act upon the soul, the agitation of which is expressed in many different modes by the features and muscles. Indeed, the language of this ethereal and inexplicable spirit speaks through every fibre, and each passion is known to an indifferent spectator, without the intervention of an explanatory sound. It would seem, from the sudden and involuntary experience of agitation, that the passions were implanted in the soul as centinels watchful for its safety, and that of the person it inhabits. Were this the truth, some have observed, it might be supposed, that every impulse would be found correct and proper: sad conviction, however, proves, it is added, that nothing can be more ill-founded than such a supposition, as not an individual exists at this moment who has not discovered, that he has feared where he ought to have esteemed, hated when he ought to have admired, loved when he ought to have detested, and in numerous instances been blinded either by misconceived partiality, or equally unjust prejudice. Such, at least, is the decision of unthinking persons; those, on the contrary, who do justice to the Creator, feel and acknowledge, that the passions are the most correct of centinels, particularly when guided and governed by the superior gift of reason.

Accident may have distorted the features, and deranged the graceful turn of the limbs of an unfortunate individual; by this means he becomes an object of disgust, and he probably resembles the wretch who commits midnight assassination, or secretly stabs reputation by malicious inferences: let this unhappy person meet unexpectedly with two others, who have never seen him before, one under the influence of uncontrolled passions, and the other completely master of them; the former exclaims with terror, and shuns the presence of the ill-favoured mortal; the latter receives the same alarm from the soul, but giving the reins to reason, a cool examination takes place, and by reading the mind of the terrific object, he finds nothing to fear, but probably much to admire and esteem, and perhaps secures a friend, which the other loses by absurd precipitation.

The passion of fear has evidently been implanted in us, in order to preserve the extremely frail and delicate organs which compose our bodies; but such is the perverseness of our education, that this very passion is frequently the immediate cause of our destruction. This certainly never could have been the case, had we been taught from our infancy to govern it by reason: the prescience of the soul shows instantaneously the extent of the danger to be apprehended; were the impulse less arbitrary, it would be disregarded; the alarm given, reason is always at hand to suggest the means of preservation; nor can her dictates frequently fail, though it must be admitted circumstances do sometimes exist which preclude a possibility of extrication.

In reasoning upon this subject, facts ought to supersede theory, and it should be our endeavour, at least, to be of service to the community, by showing the public their errors from their own conduct. In this particular it is, unhappily, in our power to cite a recent instance of the fatal effects of uncontrolled fear. We allude to the loss of eighteen lives, in October, 1807, at Sadler's Wells, where the brutal conduct of two persons in a state of intoxication, insulting every person near them, excited alarm in some weak females, seated above them in the boxes; which natural and necessary emotion was suffered, by indulgence, to confound their senses of seeing, hearing, and smelling, to such a degree as to derange their ideas even to madness. In this state of fear they exhibited the most frantic gestures, exclaimed fire in their delirium, and soon lost the power of delivering themselves from the supposed danger. The horror of being burned to death immediately spread; all ranks of persons, from the pit to the gallery, obeyed the dictates of fear, and each endeavouring to escape, pressure, and suffocation, and death followed. The performers, in full possession of their faculties, terrified at the scene before them, joined with the managers, by signs and intreaties, to obtain quiet and silence in vain. In vain did they urge that the stage could not be on fire and they not

be sensible of it; in vain did they exclaim, even with speaking trumpets, that the audience themselves might perceive that smoke or flame appeared in no part of the theatre. Still they fled to certain suffocation, still they precipitated themselves from the gallery to the pit, till the place was nearly emptied.

Such is the simple narrative of this dreadful scene; but how is it to be accounted for?

Were we to argue from the precise occurrences of the scene just described, we must suppose that the perceptions of the soul are greatly confined or limited; that confused or imperfect sounds, striking upon the drum of the ear, convey ideas to the former which it is incapable of separating and appropriating; but that being roused to a sense of some sort of danger, resemblances are taken for originals. Thus, perhaps, some of the execrations uttered by the rioters may have sounded like the word fire, to the female or females who repeated it, whose weakness and want of resolution deprived them of the power of ascertaining, from every surrounding object, that the conceptions of their fears were utterly unsupported by facts. Nor was their faculty of recollection sufficiently strenuous to remind them that the passages from the boxes of the theatre they were in was so capacious as to admit of the exit of every individual in ten minutes, in a manner that would not injure an infant; that the whole of the stage being a vast tank of water, it was impossible that the engines behind the scenes should want a supply; besides the total absence of alarm in the countenances of the performers, it might be supposed sufficiently indicated, that the only place concealed from their view was entirely free from danger. The fears of those who sat in the back part of the gallery were far more justly excited; they saw nothing but the stage, and might suppose that the boxes or pit beneath them was on fire, and their own screams prevented their hearing the intreaties for silence from the stage; it is, therefore, not altogether to be wondered at that they endeavoured to escape.

Dr. Cogan very truly observes, that an idea is the grand exciting cause of every passion and affection: it instigates the whole of our conduct; it pervades and directs every internal operation of the mind; it is clearly known by every one who has the power of thinking, but it defies every definition. That this is the truth no one will dispute: hence it appears, that the Divinity has given us an invisible active spirit, possessing the means of perception, and even of foresight, extending to a hint of what would be hurtful, or beneficial, or pleasant, on which it is intended reason, improved by education and experience, should act and bring to perfection.

Admitting these premises, it necessarily follows, that man has the means of foreseeing what will prove injurious, or the reverse, and the power of turning those means to the full use intended. These we shall term the control of the passions; were they carried to the extent of which they are capable, half the present unhappiness of life might be avoided, and an endless catalogue of dangers prevented.

We manage the horse, and command his passions; nay, we teach him to face the fire and thunder of cannon: though we know that when untutored his fears fascinate him to the spot where that element surrounds and would destroy him, shall it then be said that the infant must advance into life with all its passions advancing in equal proportion, have we reason given us to tutor the horse and neglect our own species? Surely not. Let the latter, then, be taught, in the earliest period of existence, to fear nothing but moral evil; let the child be led into the very jaws of danger, and taught the method of deliberate retreat, that he may not faint before shadows, and magnify fancies into gulfs of destruction.

Parents, nurses, and ignorant teachers lay the foundation of much misery, by exciting fears of imaginary beings in the minds of infants. This method of frightening them into propriety of conduct turns the thoughts of the child from contemplating the appearance of natural objects, whose operations are easily comprehended, into a dark vacuum, where fancy finds floating spectres of horrid form and mien, which haunt them sleeping, and pursue them in the dark through the remainder of their lives; and to this cause we principally attribute the sudden magnifying of the soul's hints of danger, which finding nothing real to work upon, the thoughts are wrought into chaos and frenzy, confusing the organs of speech, depriving the muscles of the power of action, and sometimes the body of existence.

Fear operates in a variety of ways upon the human frame, and its effects depend, in a great measure, on the temperament of the body under its influence. Females, when suddenly and violently alarmed, fre-

quently utter a piercing cry, and faint into total insensibility. Others are seized with hysterics, or a general convulsion of the whole system; and in slighter degrees of fear the eyes are fixed on the object of terror, while the feet involuntarily perform the office of flight. When the cause of fear strikes the soul without a possibility of an intervening conception of it, an universal start of the nerves and muscles is the consequence; the contraction of the skin of the head raises the hair upright; the blood rushes back to the heart, which palpitates most rapidly; the mouth opens; the eyes undergo the same operation, and are stretched in eager gaze after the dreaded object; and an uniform trembling and faintness of the limbs take place. The best painters exhibit terrified figures with their arms extended forward, as if to resist an assault, or rather to prevent a substance from rushing against them; one of the legs set firmly back, the mouth open, the eyes glaring, the skin of the temple wrinkled, and a deadly paleness overspreading their features.

We shall support our observations on this first of the human passions by a short quotation from a late and approved writer. "Excessive fear is, by far, the most painful of all our sensations. Fear is wholly engaged in the contemplation of misery, which contains not a single particle in its nature, calculated to soothe and mitigate its agonizing influence. But still it is the vigilant guardian of well-being. It tries every expedient, and makes every effort to escape the evil so much dreaded. Were we indifferent about things pernicious in themselves, they would frequently seize us totally unprepared, and overwhelm us when we might have escaped from them."

Fear may be generally attributed to an apprehension of we know not what calamity, one which may be traced to a cause, perhaps, but not to its full effects. Apprehension is a modification of the same passion with sensations of uneasiness and restless watchings. Terror, on the contrary, has its cause in full view; the eye sees it, the ear hears it, and the whole frame feels, by anticipation, the moment when it shall be crushed or overwhelmed by the approaching power. Consternation is a species of fear; a discovery is dreaded, which produces punishment, guilt causes agitation, and the emotions of consternation often occasion suspicion where none was entertained before. The indications of this passion are flushed and deranged features, hurried actions, and confused and contradictory speeches. Each of the above designations of passion apply to the universal desire entertained by man for his own preservation.

We shall next proceed to notice a passion equally destructive and pernicious in its effects upon the body, but far less innocent, anger, which is capable of being raised from a slight flushing of the face to furious rage. The discovery of an intended injury, a blow unexpectedly received, or insulting language, excite what is generally termed anger. Rage, on the contrary, more particularly proceeds from a reiteration of either of the above causes; such, at least, is anger founded on principles capable of some slight justification; but it must be admitted, that this passion is often generated by causes trivial and unimportant: difference of opinion in the course of common conversation, a dispute whether a window sash shall be opened or remain shut, have been known to produce anger, which could only be appeased by the shedding of blood. Passions arising from causes of this description, and indulged to excess, place human nature in a most degrading point of view, and exhibit the violence of self-love in the strongest colours. The soul in this instance gives the same warning of probable injury which takes place in the case of fear, with the difference of suggesting means of prevention. Anger braces the nerves, the muscles become rigid, and the body rises into a posture indicating majesty and defiance, the features are animated with a strong expression of energy, and the blood flows rapidly to the face.

Rage may be termed anger degenerated into the miserable state of insanity; in some instances the first impulses of rage are too powerful for the faculties, and the person under its influence either falls dead, or sinks into an agitation which disarms him of the power of resistance or defence; he becomes pale, and trembles from head to foot, and essays in vain to utter the purposes of his soul; in others, where the constitution happens to be strong, the features are distorted, the muscles of the mouth are drawn back, the teeth grind together, the eyes are strained outwards, the brows are knit, the hands clenched, and every muscle indicates sudden exertion; the heart palpitates, and the lungs with difficulty afford air for respiration, so rapid are the cries and exclamations of the unhappy being thus moved, who becomes an object of compassion to the

spectators, but out of pity, as it is more than probable that the vengeance about to be taken will be more than commensurate with the injury received.

Anger, in its slightest degree, necessarily follows certain occurrences, the consequences of family and social connections; and its indulgence is allowable under the guidance of reason, otherwise it would be impossible to correct the aggressions of unthinking persons, or conduct the education of youth; but beyond this boundary, it becomes brutal and degrading to our nature. Anger may be made habitual by indulgence; the nerves are, by this means, rendered diseased and irritable, and the person thus situated actually falls into an universal tremor, with a species of rage, almost at the instant the ear hears, or the eye views the cause of offence; indeed some cases exist when the mind becomes inflamed at the bare suspicion of what may be said or done. Miserable are the feelings of those who suffer anger to overpower their reason, and miserable are the effects of their rapid and frequently unfounded conceptions. It may be doubted whether the mind, in this state of derangement, can be recovered to discrimination and gentleness in adults; it is, therefore, doubly necessary to repress any effervescence in the breasts of infants, who are known to feel most violent paroxysms of rage, even before their limbs are capable of supporting them, and which have been known to be fatal. This circumstance alone proves that our passions are received with life in their full vigour, consequently every means should be tried to soothe and repress them, rather than to encourage their increase, by teaching resentment against animals, friends, and inanimate objects, by the detestable practice of asking a blow from a child to beat a table or a wainscot, for coming in contact with its head or limbs, or a person or animal for some offence. Revenge is a twin-brother of anger or rage; we see but little of the movements of this branch of the passions, as they are generally secret, founded on fear, and prey on the vitals of the wretch who entertains it; it is a compound of courage and apprehension, but the latter ever predominates. Revenge is not always confined to acts, but descends to malice, which delights in insinuations and false conclusions; when successful, the human face divine becomes the type of that of a fiend, and a smile sets on the features which cannot be described.

Another gradation of anger is hatred, which arises from a real or supposed injury. Inveterate hatred is a most direful passion, distorting every word and every act of the individual the subject of it; whose smiles are equally detested with their frowns, and whose motives in all cases are supposed to be governed by an intention of injuring the possessor of this unworthy sensation. Resentment is a far more generous inmate, because it possesses the power of discriminating an unintentional from a voluntary insult, and is vented generally, and immediately, in words alone. It must be obvious, that he who entertains hatred fosters an inmate which feeds upon his own vitals, even when the object hated is unconscious of its existence, or has forgot its future consequences.

Envy often produces hatred; the former being a most unreasonable passion, seems to derive its origin from an innate principle of evil; it is one, in short, which cannot be accounted for on any rational grounds. The person influenced by envy feels some deficiency, and observes another endowed with qualifications either beyond the reach of acquirement, or that may be obtained without difficulty; when the defect lies in the person or features, it might be imagined that the hopeless state of the case would produce resignation, if not content. If the acquirements disliked or envied are attainable by all mankind, emulation might be supposed to urge an attempt at rivalry: but, no; the envious person rests in listless inactivity, and suffers his mind to tear every ornament natural or artificial from the subject of his dislike, his eyes to express it, and his tongue to depreciate and lessen every movement of the involuntary enemy of his repose. Aversion is often produced by a similar cause; and yet it must be admitted, that aversions do sometimes occur in minds virtuous and pure, which require the strongest efforts to subdue them. These, however, generally proceed from the contemplation of a set of forbidding features, or some peculiarity in the manners of the individual disapproved of, and may be conquered by exertion. In another sense, aversion is proper and justifiable; the good must feel an aversion for those whose conduct is wicked or disgraceful.

Hatred is expressed by contemptuous looks, or knitting of the brows, the raising of the lips towards the nostrils, and an averted face. Envy exhibits an eagerness to see the departure of its object, when the

eyes sparkle, and the voice is tuned to ridicule. Aversion shuns the presence of the wicked, and turns the back to its presumptuous folly.

Cruelty, this perversion of our nature, for it cannot be innate, may be traced to its origin without a circuitous or theoretical process. Examine the domestic economy of most families, and the result will be that five out of six who have infants to instruct and educate, possess some animals, entertained for the sole purpose of amusing the tender years of their offspring, which are dragged by the neck and limbs from one to another, with the same indifference in the child and parents, and their attendants, as if they were inanimate representations of dogs, cats, rabbits, or birds; and should the injured animal complain or resist, the family is in arms to beat, nay, hang the innocent offender, while the child is soothed with execrations of the animal, and assurances of a cruel revenge. Can the unfortunate being thus tutored be supposed to respect the feelings of man, when opposed to his will, in the course of his future life, after having been taught to despise the cries of suffering from his earliest days? Impossible. To follow the aberrations of so hateful a disposition would require a relation of facts which are calculated to excite horror, as the exercise of it extends into a variety of acts, decidedly opposite to each other in their motives. Instances have been known of the infliction of tortures both mental and corporeal, which could not be traced to any rational cause: when it arises from revenge against real or imagined injuries, we are not at a loss for the reason why a wretch should exult in the misery of his victim; but it is shocking to reflect on the conduct of a fiend, who, after robbing an unresisting traveller, beats him almost to death. In this case, and in those cruelties frequently exercised on the brute creation, we find such a total rejection of the manly dignity of the human race, that we are almost inclined to hope the inflictors are a race of evil spirits, distinct and separate from us.

The indulgence of any of the preceding passions may lead to cruelty: even the coward indulges in this propensity when he can get his enemy into his power with safety to himself. But cruelty is not merely confined to bodily suffering; a person may be violently cruel by words, insinuations, and suggestions, that will for ever destroy the peace of individuals and families: those may be classed under the terms prejudice and censoriousness: the former is a perverse determination to resist every attempt at conciliation, where offence has been given, and to confute every assertion in favour of the victim by falsehoods and prevarication; the latter will suffer nothing in the conduct of his enemy to be correct and proper; he censures each act and each word at every opportunity; and surely nothing can be more unjustifiable and cruel. Desire is a natural but uneasy sensation of the mind; in one point of view it is a necessary means for the support of the human species, and in others it may be commendable and exactly the reverse. The desire to injure either in person or property is criminal, but a desire to effect any commendable purpose deserves all possible encouragement.

Among the minor affections of the mind which are vicious though not decidedly criminal, we must include peevishness or ill-nature. The person under the influence of this miserable feeling is seldom mischievous, as all his friends and associates are included in his fretful comments, and their general tendency disarms them of their sting. We read the state of his soul in the half angry, half sorrowful turn of his features; and we are inclined to pity him as under the influence of an incurable disease: and, in truth, peevishness often proceeds from a morbid affection of the body.

Ingratitude is a species of apathy: he that receives a benefit, and is not grateful in return, must possess an insensibility or apathy by no means to be envied. The latter term, indeed, seems to imply a total absence of feeling and passion, or a faculty of seeing and hearing every occurrence unmoved. It may, however, admit of a doubt, whether the appearance of apathy is not to be traced to a perfect command of the external actions of the features and limbs, which disguise the agitation of the mind to the common observer, at the same time that nature performs her operations in the soul without effectual obstruction.

There are other designations of the intemperate passions, or those which injure us in the present state of society, and will certainly produce punishment; but as they all refer, in some degree, to those already noticed, we shall turn our attention to a more pleasing portion of the subject. The benevolence of the Creator towards mankind has been demonstrated by the most unequivocal proofs. This cannot be dis-

puted or doubted for a moment, when it is remembered, that the first operation of the infant mind is love. The infant recognises its parent, and smiles with inexpressible delight upon her face; the smile is returned with tenfold interest, and thus commences life and the passions. Were this fact held in constant recollection, the latter would be kept in just subordination, instead of being encouraged to defeat the intentions of the divinity.

Upon examining the features of a handsome child a few weeks after its birth, when in the act of fondling its mother, and that of the latter at the same instant, it will be found that nature has made the human species in a most exquisite mould indeed. On one hand, perfect innocence has full possession of the face; on the other, recent illness, a disregard of external affairs and present happiness, has restored perfect content. Exquisite picture of perfection! how much is it to be regretted, that perverseness has made it transient. Encouraged as these our first propensities sometimes are, we find the parent attentive and anxious, instructing with eagerness, correcting with gentleness; the offspring venerating, admiring, and emulating; and all is happiness, complacency, and content. Placid and regular lines throughout the countenance point out those happy mortals for imitation, the muscles are never strained and distorted, and the painter is at a loss how to express the repose and benevolence he essays to copy.

Love, in another sense, descends one step from the above exalted station, and becomes difficult to be defined. Youth frequently feel a passion for their opposite sexes, founded upon an inexplicable emotion of the soul, which seems blinded and incapable of discrimination. In this case it is an impulse without stability, as it frequently happens that the gratification of the impelling power proves absurd and injurious; from which it appears, that love should, in the first instance, be received merely as a hint, the propriety or impropriety of which is to be examined by the test of reason, and cherished or rejected according to her dictates. Love, thus confirmed, is a blessing to the possessor, as it induces the exercise of every amiable quality towards its object, consequently, harmonizing and reconciling the soul to independent occurrences. The sensations of this passion are so tranquil, that the features are but little affected; the eyes sparkle with vivacity, when directed to the person admired, the mouth gently opens, and a serene smile is the only indication of influence on the muscles.

Hope necessarily arises from the indulgence of love, but it is a faithful attendant of every other passion; consequently, it sometimes becomes criminal. Hope is a compound of fear and desire. The person under the influence of this companion of every situation in life fixes his affections or desires upon the attainment of some favourite object or pursuit, and his mind experiences the alternate pleasures and pains of fruition and disappointment, as the prospect of attainment or want of success predominates. Indeed every individual may be said to exist from their infancy in hope; and we all die in hope of future happiness, though the hopes of our lives have too often been directed to the very means of punishment, veiled under the specious appearance of probable felicity. Hope and expectation have the same effect upon the frame and features; the heart palpitates, the countenance is enlivened by a display of eagerness and search for something invisible.

Joy is the result of success in this aggregate of self love, which is a passion, in some instances, too violent for the strength, and death or madness, and fainting succeed, when it takes place before the mind has been prepared to receive it. The most extravagant and frantic actions distinguish those whose animal spirits are in full vigour, and under little control, when it takes sudden effect; and it is, therefore, absolutely necessary to inform such persons gradually of the benefit or advantages they are about to experience. Unutterable pleasure dances in the features of those less agitated; they skip and leap from place to place, laugh, recount rapidly prospects of future happiness and intentions, and have been known to melt into tears. Such are the consequences of immediate relief from impending danger, apprehended personally or for friends, and extrication from pecuniary difficulties. Happiness is the tranquil attendant of joy, but never assumes the sway till all the turbulent emotions are subsided: then, indeed, the contemplation of future good produces an ecstatic sensation, which gradually passes into gladness, contentment, and satisfaction, the repose and completion of joy.

Pride is one of the class of improper passions, when indulged as the result of some imaginary perfection; but a consciousness

of superior worth, which renders the possessor too proud to act or say any thing derogatory to the honour of his rank and connections, is the only justifiable pride. The male or female proud of birth, of riches, elegance of person, and those who are proud without any of the advantages enumerated, are equally ridiculous and contemptible; such unfortunate self-tormentors are jealous of every occurrence, lest it should, in its consequences, trench upon their own importance; they see and hear disrespect in every movement and every sound that is uttered, and, full of alarmed dignity, the features are contracted into a contemptuous threatening frown, the head is thrown backward, the steps are measured, the hand waved, and they stalk into retirement, where a thousand stinging malicious reflections accompany and make them miserable.

Vanity is a near relative of pride; but this affection of the soul is generally, though not always, personal. They who are fortunate enough to possess superior attractions of body and features, cannot but be conscious of their claims to admiration, which are willingly answered by the public, when humility and modesty attend them; but vanity no sooner attempts to point them out by the ridiculous arts of dress, and disposition of countenance and limbs, than envy commences her operations, and contrives to excite laughter instead of applause. Richness of the habit, affected smiles to shew a fine set of teeth, and a strutting mode of walking, are sure marks of vanity.

Modesty, the direct opposite of pride and vanity, is sometimes carried to excess. The natural and acquired advantages we possess ought ever to give a tempered consequence to the front and mien. The really modest person often sinks into bashfulness, which is a most troublesome though not a vicious companion. To shrink from view and conceal our attainments is unjust to our instructors; besides, example is required in society. Modesty and bashfulness occasion apprehension and trembling, and deep blushes and hesitation in speech complete the confusion and errors committed.

We have hitherto treated on those passions which agitate the mind and body in various ways without melting the soul into what is termed sorrow, and its numerous ramifications. It is difficult to separate any of the sensations under this head from the affection of self-love, though it is beyond a doubt that much really disinterested sorrow is felt. Grief is the most violent emotion experienced by man, and the most difficult to conquer. An injury may be forgiven, an enemy converted into a friend, and resentment subdued; but grief seizes upon the soul after the loss of a relative with irresistible power, and reason exerts herself in vain to shake it off. The moralist argues against its indulgence without effect, because the loss cannot be supplied, and the mind is compelled to wander in a desert, where it searches in vain for its departed friend. Grief sometimes affects the faculties even to derangement, and produces melancholy madness, which of all the varieties of insanity is the most hopeless. In cases of this nature the organs of life are obstructed, the heart oppressed, the lungs are inflated almost to bursting, deep sighs are essayed for relief, but in vain; a sudden obstruction recurs in the windpipe, and that part of the body seems more affected than any other. The unhappy sufferers wander, lost in misery, from place to place, wring their hands, and strike their feet forcibly on the ground; raise their eyes, as if in silent ejaculation, and the muscles of their mouths are drawn down, giving the countenance the expression of dreadful agony. It is this state which is the most alarming for the safety of the senses; when tears and lamentation succeed, immediate relief is experienced, and time will produce settled sorrow.

This is attended by a composure of features more affecting to the spectator than the most vehement paroxysms of grief. The afflicted person seeks retirement to weep, loses his appetite, is careless of his dress, and views the grave and the gay with equal indifference, and, when in this state, incurs the danger of falling into an habitual melancholy, which, though often the result of the loss of friends, is not less frequently the consequence of disease. The melancholy man feels an universal listlessness; he is deprived of all desire of exertion, walks without consciousness, and reposes his limbs when fatigued by the mere impulse of nature. As it appears his mind is abstracted from all external objects, and preys only upon itself, the brilliancy of the sun, the beauty of the expanse of air and clouds, the pride of the spring, and the rigour of winter, pass in their fascinating varieties before him unnoticed, and he is only anxious to escape from them by suicide.

Resignation is one remove towards re-

turning happiness, the calmness and tranquillity of which cannot be described; but it is nearly allied to humility, or a sense that no exertion will avail to restore the loss occasioned by death, and that it is little short of presumption to oppose the weakness of human nature to the dispensations of Providence. Humility, however, bears another character, and becomes in this view a melancholy resignation or acquiescence in the consciousness of some defect of person or intellect.

Enthusiasm, or vehemence, in any pursuit may be called a passion of the soul, which exhibits its effects with the greatest violence when generated by religion. To describe its consequences would require a volume. It has led, and will hereafter lead, mankind into a thousand extravagancies, which can only be compared with the inconsistencies of madness. This cause will impel him to flagellate the body till blood follows, immure himself within a voluntary prison, and to meet death in any shape it may present itself. The consequences of this passion cannot well be described, as they belong almost decidedly to disease. Enthusiasm is the parent of despair, which it frequently produces in the minds of those who conceive that their sins in this life exceed the possibility of future forgiveness. The wretch thus situated displays all the gestures and actions of grief united with terror, a compound which is fortunately generally concealed from view by the asylums for lunatics.

We have now noticed the principal emotions of the soul, and stated our opinion that the causes of them are studiously kept from us by the great Author of that ethereal spirit; and without attempting to reason upon the probability or improbability of the opinions of others, we shall conclude this article with a slight summary of some of them.

Writers on the passions have indulged in a variety of speculations and conjectures as to the precise situation of their impetus, in hopes of ascertaining whether that is in the material animated part of man, or in the spiritual. Des Cartes and other philosophers will have their seat to be wholly in the corporeal system; and Mr. Grove, of a totally opposite opinion, concludes the passions to be "the affections attended with peculiar and extraordinary motions of the animal spirits;" and adds, that he inclines to "think that a sensation of the soul generally precedes a change in the spirits, external objects not being able to raise a ferment in the spirits till they have first struck the mind with an idea of something noble, frightful, amiable," &c. Mallebranche defines the passions as being all those agitations of the soul naturally proceeding from uncommon influence and motion in the blood and animal spirits; those he contrasts with others which are usual with decided intelligences, and which he terms natural inclinations.

Dr. Cheyne considered the passions in two points of view, spiritual and animal; the former he supposes to be the emotion produced in the soul by external objects, which become compounded and material by the intervention of the organs of life. The animal he defines by those effects produced by bodies or spirits immediately on the body. Dr. Morgan, by indefatigable observation, drew the following conclusion: "That all the grateful or pleasurable passions raise the vital tide, strengthen and quicken the pulse, diffuse the natural heat, and take off any antecedent stimulus or pressure upon the abdomen and inferior organs. And, on the contrary, the painful passions sink and depress the blood, weaken the pulse, recal and concenter the natural heat, and fix a stimulus, or compression, on the inferior organs. All the passions impress their characteristic sensations or modifications on the muscles of the larynx, and thus discover themselves by the different modulation and tone of the voice." From which he concludes, that the nerves of the eighth conjugation, or *par vagum*, are the principal instruments of the passions.

Dr. Reid doubts whether the "principle of esteem as well as gratitude ought to be reckoned in the order of animal principles, or if they ought not rather to be placed in a higher order." The same author, treating on resentment, has considered it as a sudden and instinctive animal principle, common to the brute creation and mankind, at the same time he calls deliberate resentment a rational principle.

To pursue theories further would be useless, we shall therefore conclude with the opinion of Dr. Cogan, one of the latest writers on the subject: "Without entering therefore into enquiries of this nature, which for want of data must be conjectural and unsatisfactory, it will be more consistent with my plan, simply to state interesting facts, and leave it to the metaphysician to draw such consequences as he may deem most legitimate. It must be admitted that

every passion, emotion, and affection proceeds from certain impressions or ideas excited concerning the nature, or state, or quality, or agency of the exciting cause. These ideas have undoubtedly their seat in that part of man we distinguish by the appellation of mind." This admitted, the Doctor advances that the exciting cause must change the state of it in relation to any given object, thus from total indifference the mind becomes in some particular manner interested, consequently the new impression produces a correspondent change upon the body, and in proportion to the impetus, general observation and universal phraseology founded upon that observation, demonstrates that a perceptible influence of each violent emotion is directed towards the heart, which feels different sensations, pleasant or the reverse, over which it has no controul, and from this centre diverges the influence of agitated spirits, the slightest effects of which are not visible to the spectator. "Nay," adds this gentleman, "the subject himself is not conscious perhaps of any thing more than either a change of sentiment on the perception of the stronger influence of a former sentiment connecting with something agreeable or disagreeable in this perception; a something which attaches more strongly to the object, or creates some degree of repugnance. This state of mind is styled an affection, and it appears to be totally mental; but stronger influences produce such changes, that the inward disposition becomes obvious to the spectator, through the medium of the corporeal frame. It is now called an emotion, and this may increase in strength until the whole system becomes agitated and convulsed. From this statement it appears incontestible, that the affections and passions have their origin in the mind, while emotions are corporeal indications of what passes within."

PASSION, or *Cross of the Passion*, in heraldry, is so called, because resembling the shape of that on which our Saviour is thought to have suffered; that is, not crossed in the middle, but a little below the top, with arms short in proportion to the length of the shaft.

PASSION *flower*, in botany. See PASSIFLORA.

PASSPORT, is a licence for the safe passage of any person from one port to another.

PASTE, a composition of water and flour, boiled to a consistence; used by various artificers, as sadlers, upholsterers, bookbinders, &c.

PASTE, in the glass-trade, a kind of coloured glass, made of calcined crystal, lead, and other metallic preparations, so as to imitate the natural gems. The basis of these compositions is a pure glass, prepared from pounded quartz, fused with alkali, with the addition of borax and of oxide of lead. The latter gives density to the glass, a susceptibility of receiving a higher polish, and a greater refractive power, by which the lustre is increased. Different colours are obtained by the addition of various metallic oxides. The oxide of gold gives a red; of cobalt, blue; of manganese, purple; of lead, yellow; and of iron, green: and these colours are so rich, as to be equal, or even superior, to those of natural gems, though in lustre, hardness, and durability, the pastes are far inferior. They may be distinguished by their inferior specific gravity, and their softness, which is such that they can be scratched by the knife.

PASTEBOARD, a kind of thick paper formed of several sheets of paper pasted together. The chief use of pasteboard is in binding books, making letter-cases, &c. See PAPER.

PASTINACA, in botany, *parsnip*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit elliptic, compressed, flat; petals involute, entire. There are three species; of which P. sativa, common garden parsnip, has smooth leaves, of a light or yellowish green colour, in which it differs from the wild plant; the stalks also rise higher, and are deeper channeled; the peduncles are much longer, and the flowers of a deeper yellow colour. The roots are sweeter than carrots, and are eaten by those who abstain from animal food in Lent, or eat salt fish: they are highly nutritious. In the north of Ireland they are brewed, instead of malt, with hops, and fermented with yeast; the liquor thus obtained is very agreeable.

PASTORAL, in general, something that relates to shepherds; hence we say, pastoral life, manners, poetry, &c. The original of poetry is ascribed to that age which succeeded the creation of the world; and as the keeping of flocks seems to have been the first employment of mankind, the most ancient sort of poetry was probably pastoral. It is natural to imagine, that the leisure of those ancient shepherds admitting and inviting some diversion, none was so proper

to that solitary and sedentary life as singing, and that in their songs they took occasion to celebrate their own felicity. From hence a poem was invented, and afterwards improved to a perfect image of that happy time; which, by giving us an esteem for the virtues of a former age, might recommend them to the present. And since the life of shepherds was attended with more tranquillity than any other rural employment, the poets chose to introduce their persons from whom it received the name of pastoral. A pastoral is an imitation of the action of a shepherd, or one considered under that character. The form of this imitation is dramatic, or narrative, or mixed with both; the fable simple; the manners not too polite nor too rustic; the thoughts are plain, yet admit a little quickness and passion, but that short and flowing; the expression humble, yet as pure as the language will afford; neat, but not florid; easy, and yet lively. In short, the fable, manners, thoughts, and expressions are full of the greatest simplicity in nature. The complete character of this poem consists in simplicity, brevity, and delicacy; the two first of which render an eclogue natural, and the last delightful.

PASTURE, is generally any place where cattle may feed, and in law is mostly applied to a common of pasture, or right of feeding cattle on certain waste lands. See Common.

PATE, in fortification, a kind of platform, resembling what is called an horseshoe; not always regular, but generally oval, encompassed only with a parapet, and having nothing to flank it. It is usually raised on marshy grounds, to cover the gate of a place.

PATEE, or Pattee, in heraldry, a cross, small in the centre, and widening to the extremes, which are very broad.

PATELLA, in anatomy, a bone which covers the fore-part of the joint of the knee, called also rotula, and popularly the kneepan.

Patella, in natural history, *limpet*, a genus of the Vermes Testacea: animal a limax: shell univalve, subconic, shaped like a bason; without a spine. This is a very numerous genus, containing between two and three hundred species, divided into sections. A. Furnished with an internal lip; shell entire. B. With the margin angular, or irregularly toothed. C. With a pointed, recurved tip or crown. D. Very entire, and not pointed at the tip or crown. E. With the crown or tip perforated. The most worthy of notice are the following. P. vulgata, with rough prominent striæ, and sharply crenated edges; vertex pretty near the centre; the edges often in old subjects are almost smooth. P. pellucida, with a transparent shell, marked longitudinally with rows of rich blue spots; the vertex placed near one edge; inhabits the sea rocks of Cornwall. P. græca, with an oblong shell, perforated vertex, striated roughly to the edges. It inhabits the west of England. This genus was well known to the ancient Greeks, from whom we learn that it was used for the table, and that it was found adhering to the rocks.

PATENT, something that stands open or expanded: thus a leaf is said to be patent when it stands nearly at right angles with the stalk.

Patent, or *Letters Patent*, are writings sealed with the great seal of England, by which a man is authorized to do, or to enjoy, any thing which of himself he could not. They are so called on account of their form, being open, with their seal affixed, ready to be exhibited for the confirmation of the authority delegated by them. Letters patent for new inventions are obtained by petition to the crown: they go through many offices, and are liable to opposition, on account of the want of novelty, &c. and if obtained, and it can be proved that the invention was not new, or had been made public previously to the granting the patent, they may be set aside. A patent at the lowest cost, and when no opposition is given to it, will, for fees of office, specification, &c. cost for the three branches of the United Kingdom about three hundred pounds.

PATRIOT, "a sincere and unbiassed friend to his country; an advocate for general civilization, uniting in his conduct through life moral rectitude with political integrity. Such a character is seldom found in any country; but the specious appearance of it is to be seen every where, most especially in Europe. It is difficult to say how far the term can be used in a military sense, although it is not uncommon to read of a 'citizen soldier,' and a 'patriot soldier.' Individually considered, the term may be just, but it is hardly to be understood collectively. A celebrated English writer has left a treatise, intituled, "The Patriot King;" by which he means the first magistrate of a country who acts up to the genuine principles of its constitution. It is devoutly to be wished, (human nature being so constituted as to require coercion) that

the application of military force could always be in the hands of a patriot king, who is the first soldier in the land, and would of course be entitled to the appellation of a patriot soldier. The convulsed state of Europe is such, that no country can do without soldiers. When they are employed to defend, or protect their native land, they are patriot soldiers." See James's Military Dictionary.

PATROL, in war, a round or march made by the guards, or watch, in the night-time, to observe what passes in the streets, and to secure the peace and tranquillity of a city or camp. The patrol generally consists of a body of five or six men, detached from a body on guard, and commanded by a serjeant. Patrols are formed out of the infantry, as well as the cavalry. When a weak place is besieged, and there is reason to apprehend an assault, strong patrols are ordered to do duty; those on foot keep a good look out from the ramparts, and those that are mounted take care of the outworks.

PATRON, both in the cannon and common law, signifies him that hath the gift of a benefice or parsonage.

PATRONYMIC, among grammarians, is applied to such names of men and women as are derived from those of parents or ancestors. Patronymics are derived, 1. From the father, as Pelides, *i. e.* Achilles, the son of Peleus. 2. From the mother, as Philyrides, *i. e.* Chiron, the son of Philyra. 3. From the grandfather on the father's side, as Æacides, *i. e.* Achilles, the grandson of Æacus. 4. From the grandfather by the mother's side, as Atlantiades, *i. e.* Mercury, the grandson of Atlas: and, 5. From kings and founders of nations, as Romulidæ, *i. e.* the Romans, from their founder, King Romulus.

PAVEMENT, a layer of stone, or other matter, serving to cover and strengthen the ground of divers places for the more commodious walking on. In London the pavement for coach-ways is chiefly a kind of granite from Scotland: and on the footpath Yorkshire paving is used; courts, stables, kitchens, halls, churches, &c. are paved usually with tiles, bricks, flags, or fire-stones; and sometimes with a kind of free-stone and rag-stone. In France, the public roads, streets, courts, &c. are paved with gres, a kind of free-stone. In Venice, the streets, &c. are paved with brick; churches sometimes with marble, and sometimes with Mosaic work. In Amsterdam, and the chief cities of Holland, they call their brick pavement the burgomaster's pavement, to distinguish it from the stone or flint pavement, which is usually in the middle of the street, serving for the passage of their horses, carts, coaches, and other carriages; the brick borders being designed for the passage of people on foot. Pavements of free-stone, flints, and flags, in streets, &c. are laid dry, that is, are retained in a bed of sand; those of courts, stables, ground-rooms, &c. are laid in mortar of lime and sand, or in lime and cement, especially if there be vaults or cellars underneath. Some masons, after laying a floor dry, especially of brick, spread a thin mortar over it, sweeping it backwards and forwards, to fill up the joints. Thirty-two statute bricks laid flat, pave a yard square; sixty-four edgewise. The square tiles used in paving, called paving bricks, are of various sizes, from six to twelve inches square. Pavements of churches, &c. frequently consist of stones of different colours, chiefly black and white, and of several forms, but chiefly square and lozenges, artfully disposed.

PAVEMENT *of terrace*, is that which serves for the covering of a platform, whether it be over a vault, or on a wooden floor. Those over vaults are usually stones squared, and bedded in lead. Those on wood are either stones with beds, for bridges; tiles, for ceilings in rooms; or lays of mortar, made of cement and lime, with flints or bricks laid flat, as is still practised by people in the east and south, on the tops of their houses.

PAVETTA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-form, superior; stigma curved; berry two-seeded. There are seven species.

PAVILION is sometimes applied to flags, colours, ensigns, standards, banners, &c. See FLAG, &c.

PAVILION, in heraldry, denotes a covering in form of a tent, which invests or wraps up the armories of divers kings and sovereigns, depending only on God and their sword. The pavilion consists of two parts; the top, which is the chapeau, or coronet; and the curtin, which makes the mantle. None but sovereign monarchs, according to the French heralds, may bear the pavilion entire, and in all its parts. Those who are elective, or have any dependance, say the heralds, must take off the head, and retain nothing but the curtains.

PAULLINIA, in botany, a genus of the Octandria Trigynia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx five-leaved; petals four; nectary four-leaved, unequal; capsules three, compressed, membranaceous, connate. There are seventeen species, all natives of warm climates.

PAVO, the *peacock*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill convex and strong; head covered with turned-back feathers; nostrils large, feathers of the tail long, broad, expansile, and adorned with rich eye-like spots. There are four species. The P. cristatus, or crested peacock, was originally brought from India, where it is found in its wild state, and exhibits all its maturity of growth, and glow of colouring. It was an article of importation from that country to Palestine, in the reign of Solomon, in those fleets which conveyed once in three years to the court of that magnificent monarch, invaluable treasures of art and nature. In this country, peacocks do not attain their full and brilliant plumage till their third year. The female lays five eggs, and is particularly solicitous to conceal them from the male, which not unfrequently destroys them. These birds feed almost solely on insects and grain. They prefer elevated situations for roosting, choosing the tops of houses and the highest trees for this purpose. They were considered as luxuries for the table by the Romans, and the young ones are now regarded as a delicacy. Their voice is harsh and dissonant, and in perfect contrast to that beauty exhibited by their plumage, which, in the language of Buffon, "seems to combine all that delights the eye in the soft and delicate tints of the finest flowers, all that dazzles in the sparkling lustre of the gem, and all that astonishes in the grand display of the rainbow." See Aves, Plate XI. fig. 2.

PAUSE, a stop or cessation of speaking, singing, playing, or the like. The use of pointing, in grammar, is to make proper pauses in certain places. There is a pause in the middle of each verse; in an hemistich it is called a rest or repose.

PAUSE, in music, a character of silence, or rest, called also by some a mute figure, because it shews that some part or person is to be silent, while the rest continue the song. Pauses are used either for the sake of some fugue, or imitation, or to give a breathing time; or to give room for another voice, &c. to answer what this part sung, as in dialogues, echoes, &c. In military affairs it is essentially necessary for all officers to accustom themselves to a most minute observance of the several pauses which are prescribed during the firings. According to the regulations, the pause between each of the firing words, "make ready, present, fire," is the same as the ordinary time, viz. the seventy-fifth part of a minute, and no other pause is to be made between the words. In firing by companies, by wings, each wing carries on its fire independently, without regard to the other wing, whether it fires from the centre to the flanks, or from the flanks to the centre. If there are five companies in the wing, two pauses will be made between the fire of each, and the make ready of the succeeding one. If there are four companies in the wing, three pauses will be made betwixt the fire of each, and the make ready of the succeeding one. This will allow sufficient time for the first company to have again loaded, and shouldered at the time the last company fires, and will establish proper intervals between each. In firing by grand divisions, three pauses will be made between the fire of each division, and the make ready of the succeeding one. In firing by wings, one wing will make ready the instant the other is shouldering. The commanding officer of the battalion fires the wings. In firing companies by files, each company fires independently. When the right file presents, the next makes ready, and so on. After the first fire, each man as he loads comes to the recover, and the file again fires without waiting for any other; the rear rank men are to have their eyes on their front rank men, and be guided by, and present with them.

PAUSUS, in natural history, a genus of insects of the order Coleoptera. Antennæ two-jointed, the upper joint very large, inflected, hooked, pedicillate; head pointing forwards, with a convex, jugular triangle; thorax narrow, unequal, contracted; shells flexile, deflected, truncate; four feet placed at the fore part of the breast, thighs with minute appendages; tarsi four-jointed. There are five species; two of which are fully described in the "Linnæan Transactions," vol. 4. P. microcephalus: head unarmed; club an oblong sphere; shells as long as the body, not punctured; shanks linear. It inhabits the Banana islands. P. sphærocerus: head horned; club globular; shells shorter than the abdomen, punctured; shanks dilated at the tip. It is found at

Sierra Leone; wanders about in the night-time, during the months of January and February, and becomes blind or benumbed on the approach of light; the globes of the antennæ give a kind of phosphoric light in the dark; the body is polished, and of chesnut colour, a little narrower than the last; horn between the eyes straight, conic, tipped with a tuft of cartilaginous hairs; eyes larger; thorax the same breadth as the head; wings shining and violet.

PAW, *patte*, in heraldry, the fore foot of a beast, cut off short. If the leg be cut off, it is called gambe. Lions paws are much used in armory.

PAWLE, in a ship, a small piece of iron bolted to one end of the beams of the deck close to the capstan; but yet so easily, as that it can turn about. Its use is to stop the capstan from turning back, by being made to catch hold of the whelps; they therefore say, heave a pawle; that is, heave a little more, for the pawle to get hold of the whelps: and this they call pawling the capstan.

PAWN, among miners, a pledge put into the bar-master's hand, at the time when the plaintiff causes the bar master to arrest the mine.

PAWNBROKER. See BROKER.

PAY, in the sea-language. The seamen say, pay more cable, when they mean to let out more cable.

PAYING, among seamen. When the seams of a ship are laid over with a coat of hot pitch, it is called paying her; and when this is done with canvass, parcelling; also when, after she is graved, and the soil burned off, a new coat of tallow and soap, or one of train oil, rosin, and brimstone boiled together, is put on her, that is also called paying of a ship.

PAYMENT, in law, is the consideration or purchase-money for goods, and may be made by the buyer giving to the seller the price agreed upon, either by bill or note, or by money. Where a day certain is appointed for payment, the party bound shall be allowed till the last moment of the day to pay it in, if it be an inland bill. Payment of money before the day, is, in law, payment at the day; for it cannot, in presumption of law, be any prejudice to him to whom the payment is made, to have his money before the time; and it appears by the party's receipt of it, that it is for his own advantage to receive it then.

PEACE has been represented allegorically as a beautiful female, holding in her hand a wand or rod towards the earth, over a hideous serpent, and keeping her other hand over her face, as unwilling to behold strife or war. By some painters she has been represented holding in one hand an olive branch, and leading a lamb and a wolf yoked by their necks in the other; others again have delineated her with an olive branch in her right hand, and a cornucopia, or horn of plenty, in her left. At Rome a celebrated temple was erected for the goddess of peace, which was furnished with most of the rich vases and curiosities taken out of the Temple at Jerusalem. The Temple of Peace, built by Vespasian, was three hundred feet long, and two hundred feet broad. Josephus says, that all the rarities which men are accustomed to travel to see, were deposited in this temple.

PEACE, in law, signifies a quiet and harmless behaviour towards the King and his people. The King, by his office and dignity royal, is the principal conservator of the peace within all his dominions; and may give authority to any other to see the peace kept, and to punish such as break it; hence it is usually called the King's peace. All the great officers of state are generally conservators of the peace, throughout the kingdom, and may commit all breakers of it, or bind them in recognizance to keep it. Also the sheriff, coroner, constables, and tithingmen, are conservators of the peace within their own jurisdiction, and may apprehend all breakers of the peace, and commit them till they find sureties to keep the peace.

PEACH, in botany. See AMYGDALUS.

PEACOCK. See PAVO.

PEARL, a concretion formed in several species of shells, as in some species of the oyster and the muscle. It has been regarded by some persons as a morbid concretion, owing to an excess of shelly matter, and by others it is supposed to have originated in a wound of the shell containing the animal. Pearls are of a silvery or blueish-white colour, and very brilliant. As they consist of concentric layers of carbonate of lime and membrane, alternately arranged, the refraction of light is ascribed to the lamellated structure. See SHELL.

PEARL, *mother of*, is the shell not of the pearl oyster, but of another sea-fish of the oyster kind. This shell on the inside is extremely smooth, and of the whiteness and water of pearl itself; and it has the same lustre on the outside, after the first laminæ or scales have been cleared off with

aquafortis and the lapidaries mill. Mother of pearl is used in inlaid works, and in several toys, as snuff-boxes, &c.

Pearl, in heraldry, in blazoning with precious stones, is the same with argent, or white.

Pearl *ash*, an alkali used in various manufacturing processes: it is potash mixed with different heterogeneous substances. See Potash.

Pearl *fishery*. The most important fishery to England at present is that at Ceylon. The origin of this method of procuring a valuable ornament for the person must have arisen from accidentally discovering the pearl within oysters taken for food is evident; but it is impossible to ascertain when the search became systematical, though it is extremely probable it has been so for very many ages.

The pearl oysters of the coast of Ceylon are all of one species, and possess the same regularity of form; but they assume different qualities, and have different denominations, suited to the nature of the ground where they are situated, and from the appearance of zoophytes adhering to the external surface of their shells. They resemble a cockle in shape, which is an imperfect oval, and their circumference is generally about nine inches and a half, having a segment as it were cut off where the joint of the two shells occurs. The interior of those is far more brilliant and beautiful than the pearl they enclose, and the outside is smooth, except when injured by the usurpations of sponges, corals, and other marine productions. The flesh of the animal is white, and of a glutinous consistency.

Perhaps no class of animated nature undergoes more unmerited persecution and destruction than the pearl-oyster; when situated in their native regions, they afford a foundation for the habitations of other animals, and millions of them are dragged from their banks, and thrown away, for what they are vainly supposed to contain, and that an intruder or a disease. One of the banks at Ceylon furnishes oysters to which zoophytes are attached, apparently belonging to the class of sponges, and those generally resemble a funnel or cup, and grows to a size that completely overshadows the oyster; others of different banks have a substance adhering to them tinged with red. The above are found to contain the finest pearls: some escape free from incumbrance, and thousands are compelled to bear trees of coral on them of five times their own weight.

The oyster is fastened to the rocks at the bottom of the sea by quantities of hairy fibres. By this means they are not readily swept from their original station, and yet possess the advantage of being conveyed to some distance from it by the motion of the water; besides they are connected to each other in the same manner. It frequently happens that an old oyster, surrounded by young ones, is brought up by the divers, and the latter have been ascertained to possess, even when little larger than a grain of sand, the power of moving themselves by the extension and contraction of what is termed the beard. The violence of the waves at the time of the monsoons occasions great changes in the state of the banks, when incredible numbers of them are buried by the shifting of sand, and that is sometimes removed by the same power acting in a contrary direction.

It is supposed, from many concurring circumstances, that the pearl-oyster arrives at maturity at the close of seven years: after this period it is imagined that it dies, when the body decaying is washed away by the sea: a bed was discovered a few years since composed almost wholly of empty shells. The precious substance, which invites the exertions of man to obtain it, has been generally supposed to be a disease peculiar to the animal; but were this the fact, it is extremely prevalent amongst this description of oysters, as every individual of the species is found to be accompanied by a certain proportion of minute particles, which are evidently the pearl in the first stages of formation; hence it may be fairly supposed, that they are in some essential degree useful, rather than prejudicial to the inhabitant of the shells, of the nature of which it decidedly partakes, and is composed of a number of layers, moveable by a skilful person to the improvement of the pearl, as it sometimes happens the exterior coat only may be discoloured or injured. When the pearl is in a state of perfection they are of a brilliant white, some have been found of a beautiful tint of pink, of the colour of gold, and a few entirely black. These variations are, however, very uncommon.

The pearls are discovered near the angles of the shell, and close to the hinge, where the animal is most thick and fleshy; they are generally numerous, and in some instances 150 have been taken from one oyster; on the other hand, an hundred oysters have been opened whence a pearl could not be extracted fit for any purpose whatever.

Attempts were made some years past to transplant this species of oysters, but without success, as they invariably died during their transportation.

The first step previously to a fishery is the examination of the banks, which takes place at the end of October, during the short interval of fine weather usual between the close of the south-west monsoon and the commencement of the north-east. One pilot, two divers, and eight or more sailors, to each boat, are employed upon this service, and there are generally nine boats. The superintendant on the part of government accompanies the principal arripanaar, or pilot, who is taught his profession from his infancy, inheriting it from his father, in the manner of most occupations in the East. The boats visit the banks in a body, and the divers frequently descending, ascertain its exact position, and at the same time bring up a thousand or more oysters as specimens, which are examined by persons who, from experience, are enabled to judge whether it is probable they are of an age calculated to answer the purposes of the intended fishing: this examination is not, however, deemed sufficient, and the oysters are opened, when the pearls are extracted, and after sorting them they are valued. It is really shocking to humanity to reflect, that if one thousand oysters produce as many pearls as are worth three pounds sterling, the fishery is undertaken, as it has been found that the examination of that number is a sufficient designation of success, or the reverse.

In the progress of this preliminary part of the undertaking, the oysters are found at various periods of their growth: those not more than one year old are very small, being less than an inch in circumference, and the full grown oysters are as large as the palm of the hand of a man: between the ages of four and five years the seed pearl only is discovered; but after this period they increase in size very rapidly; and, as has been before observed, they die after the eighth year. After completely satisfying themselves as to the probability of future success, the result is published, for the information of those who may be inclined to partake of the probable advantages. Since the island of Ceylon has been a part of the British empire, each fishing season has either been reserved for the exclusive use of government, or rented to speculative persons: but the produce has never amounted to 200,000*l.* on any one occasion. The most common practice is to farm the season to an individual, who lets the right of partaking to others.

The fourteen banks, or beds, on which the oysters are found, are situated in the bottom of the gulph of Manaar, and are included in a space about thirty miles in length, from north to south, and twenty-four in breadth. It has been ascertained, that the largest of those beds is ten miles long, and two broad; the remainder are much smaller; nor are they all equally productive, as it seldom happens that more than three beds can be marked for use in any given season. The spots where the oysters lay are not raised higher than the surrounding parts, except by their accumulation, and the coral rocks, on which the most valuable are placed, are on a level with the sand: the depth of water over them varies from eighteen to ninety feet, and the most convenient and best fishing is at the depth of between six and eight fathoms. When it is thought proper to undertake a fishery, advertisements are issued in the English and Malabar languages, inviting the possessors of boats suited for the purpose, and all divers, to meet on the 20th of February in the bay of Condaatchy: vessels of this description assemble from various places on the coast of Coromandel, completely equipped, and furnished with every necessary for the accomplishment of their intentions: those are open, of about one ton burthen, forty-five feet in length, seven or eight wide, and three deep in the hold; and are so constructed as to draw not more than eight or ten inches water, unless they are heavily laden, and are navigated with one sail only. They have a complement of twenty-three men, whose employments are thus appropriated: one pilot, one man for the helm; another to take care of the boat; one to lade out water; ten divers; ten mundrees, who haul up the divers, the stones, and the baskets; and a peon attends on the part of the renter, to take care that his interests do not suffer from fraud.

A second examination of the banks takes place a few days before the operations begin, which is merely for the purpose of anchoring buoys to point out the situation of the banks, and those parts of them most abounding with the object of search. A small sloop is from the first stationed in the centre of the banks, where she remains for the double purpose of guarding the buoys, and as a guide to the boats. The pilot boats make a circuit of twelve or fifteen miles

round the sloop, sounding and sending down the divers, and upon discovering a place remarkable for the number of oysters, a buoy is immediately placed over it, which consists of triangular rafts of wood, fastened by a cable attached to a wooden anchor, sunk by two stones. The rafts support flags of various colours; and drawings of these are inserted in a book, where a minute description is given of the name, quality, and age of the oysters on the bank under each flag. Three hours sailing of the boats employed in the pearl fishery from the shore of Condaatchy, or a distance of about fifteen miles, occurs between the banks and that place: unfortunately the land near them is so low, that it is impossible to make use of it in ascertaining their position; it becomes, therefore, absolutely necessary to renew at each fishery the fatiguing operation of sounding and diving, the buoys being all removed at the close of their labours, as they would serve to point out the places for depredators to dive with success.

Mr. Cordiner, from whose late excellent account of Ceylon we have extracted most of the preceding particulars, says, "As the boats arrive at Condaatchy to be employed in the fishery, they are regularly numbered, and their description and the names of their crew are registered in a book. The fishery for the season of 1804 was let by government to a native of Jaffnapatam, who had resided for some years previously to it on the coast of Coromandel. For thirty days fishing, with 150 boats, he came under an obligation to pay 300,000 Porto Novo pagodas, or 120,000*l.* sterling. He sold the right of fishing to some of the best equipped boats for 3000 pagodas each, and that of others for 2500; but kept by far the greater part of them to fish on his own account."

After every arrangement is completed, and the boats are ready to put to sea, their navigators and the divers are roused from their slumbers by the discharge of a cannon, the sounding of horns, and the beating of a kind of drum, called by the natives *tom toms*: this signal is generally made rather before midnight, when a breeze from the land prevails; the confusion that immediately follows the movements of upwards of six thousand persons in the dark may be better conceived than described; but in defiance of every obstacle, these silly people will not depart till they have performed certain ablutions and incantations, calculated, as they suppose, to forward their views. When they have reached the banks they cast anchor, and wait the approach of day; which no sooner arrives than each boat takes its station: at six or seven o'clock the diving commences. To facilitate this operation, a species of open scaffolding is projected from each side of the vessel, and it is from the scaffold the tackle is suspended, three stones on one side and two on the other. The author we have just mentioned gives so clear and comprehensive an account of this dangerous business, which he saw performed, that we shall give part of it in his own words. "The diving stone hangs from an oar by a light country rope, and slip knot, and descends about five feet into the water. It is a stone of 56 *lb.* weight, of the shape of a sugar loaf. The rope passes through a hole in the top of a stone, above which a strong loop is formed, resembling a stirrup-iron, to receive the foot of the diver," who is entirely naked, except a piece of cahie wrapped round his waist; swimming near the side of the vessel, he takes the rope in one hand, and places his foot in the stirrup on the stone; a basket is then thrown into the water to him, made of a hoop and network below it, in which he places the other foot: after preparing his lungs for ceasing to breathe, he presses his nostrils firmly with one hand, and with the other pulls the rope forming the slip-knot; the stone carries him instantly to the bottom, where he no sooner arrives, than he disengages himself from the stirrup, which, with the stone, is immediately drawn up by the people in the boat. The diver throws himself forward upon his face, and grasps every thing in his way as rapidly as possible, and putting it into the basket, gives a signal when it is full by pulling the rope, when that also is hauled up; he then ascends by the rope, and frequently arrives at the surface before the basket: such is the consequence of custom, that though the diver cannot descend again without an interval of rest, he seldom enters the boat, remaining swimming and floating about during the whole day.

Besides the other dangers peculiar to this pursuit, the divers are liable to be devoured by sharks; but whatever may be the cause, an accident seldom occurs, which these superstitious people attribute to the powerful aid of shark charmers, without whom, and the exercise of their diabolical incantations, they will on no account undertake their labours. The most experienced diver has never been known to remain longer than one minute and a half under water, in

which time he may gather 150 oysters, if they are numerous; but he sometimes gains not more than from five to a dozen, accompanied by coral pieces of rock and other substances, for he has no time to separate and examine what he seizes. When 300 boats are employed in the fishery, it is supposed that at least 1500 divers are constantly descending, the noise of which resembles the incessant roaring of a cataract. The return of the fleet in regular order, at one or two P. M. and their arrival, with the crowds waiting to welcome their return, presents a very animating and gratifying spectacle.

The method adopted to extract the pearls is dreadfully disgusting and unwholesome, as they do not undertake this operation till the oysters have been deposited in heaps for ten days, or till the flesh has become decidedly putrid: the reason for so doing is obvious, as the particles of decayed matter and maggots are readily floated off by repeated washings in inclined receptacles, so contrived as to arrest the progress of even the smallest pearls, as they descend by their weight. Every possible precaution is taken, by picking and sifting, to secure the whole of the produce, and yet it is said that vast numbers are lost.

After the most valuable are selected, they are sent to be drilled; a most ingenious and delicate operation, which is thus performed: a piece of wood in the shape of an inverted cone is placed upon three legs, raising it about one foot from the ground: holes of various dimensions are made in the surface to receive the pearls: the person who drills sits close to the machine; he then drives the pearls steady into their sockets. "A well-tempered needle is fixed in a reed five inches long, with an iron point at the other end, formed to play in the socket of a cocoa nut shell, which presses on the forehead of the driller. A bow is formed of a piece of bamboo and a string. The workman brings his right knee in a line with the machine, and places on it a small cup, formed of part of a cocoa nut shell, which is filled with water to moderate the heat of friction. He bends his head over the machine, and applying the point of the needle to a pearl sunk in one of the pits, drills with great facility, every now and then dexterously dipping the little finger of his right hand in the water, and applying it to the middle, without impeding the operation. In this manner he bores a pearl in the space of two or three minutes, and in the course of a day perforates 300 small, or 600 large pearls."

There are different methods of fishing for pearls practised in other parts of the world; but as the Ceylon fishery eclipses them all, and the simplicity of the invention is so obvious, it would be well if it were universally adopted.

PEARL-*spar*, is a fossil of the calcareous kind, being composed of carbonate of lime, with the oxides of iron and manganese: it has received different names, and occurs massive, disseminated, and crystalized: its colours are white, often with shades of grey, yellow, or red; but by mere exposure to the air its colour darkens, it becomes brown, and at length nearly black. Specific gravity about 2.8. It does not melt before the blow-pipe, but blackens: it effervesces with acids: it is said by Bergman to consist of

Carbonate of lime	50
Oxide of iron	22
Oxide of manganese	28
	100

PEARLSTEIN, or PEARLSTONE, in mineralogy, occurs in round and longish vesicles. Its lustre is shining and pearly, and its colour varies from the pearl to the flesh-red and greyish black. It is composed of thin, concentric, lamellar concretions. It is translucent on the edges, easily frangible, and soft. It occurs in porphyry, and contains balls of obsidian, and is found in Hungary. It is composed of

Silex	75.25
Alumina	12.
Oxide of iron	1.6
Potash	4.5
Lime	2.5
Water	2.5
	98.35
Loss	1.65
	100

PEAT, or, as it is sometimes called, TURF, is a congeries of vegetable matter, in which the remains of organization are more or less visible; consisting of the trunks of trees; of leaves, fruits, and stringy fibres, the remains of aquatic mosses. It occurs in extensive beds called peat mosses, occupying the surface of the soil, or covered to the depth of a few feet with sand, gravel, and other matters. It is met with in great abundance in the northern, and in some of the central districts of Europe: in moist,

uncultivated, mountainous tracts, and likewise in low vallies and fenny plains; and in several parts of the western shore of Great Britain. The depth of peat mosses is very various, from a few feet to twelve or fifteen yards: its consistence is very various; sometimes in a semi fluid state, forming a black, impassible wilderness, studded here and there by tufts of rushes: when more solid, it is scantily covered over with heath and coarse grasses: in this state it is passable by sheep and other animals, especially during the dry season of the year. In deep peat mosses the upper part is loose, and less inflammable than the lower part of the bed. When of a good quality it is moderately compact, and may be readily cut in small masses of the size of bricks. By exposure to the air it dries, and becomes very inflammable. In this country it is the common fuel of large districts of Wales and Scotland, and of some parts of England, where coal is scarce and dear. Its ashes are in high estimation as a manure, being applied in the form of a top-dressing.

PECK, a measure of capacity, four of which make a bushel.

PECORA, in natural history, the fifth order of the class Mammalia. They have no fore-teeth in the upper jaw, but several in the lower; feet hoofed, cloven: they live on herbs, chew the cud, and have four stomachs; *viz.* the paunch, to macerate and ruminate the food; the bonnet, reticulate, to receive it; the omasus, of numerous folds, to digest it; and the abomasus, to give it acescency, and prevent putrefaction. There are eight genera, *viz.*

Antelope	Capra
Bos	Cervus
Camelus	Moschus
Camelopardalis	Ovis.

PECTIS, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ, Corymbiferæ, Jussieu. Essential character: calyx five-leaved, cylindric; florets in the ray five; down awned; receptacle naked. There are four species. These are annual plants, and natives of the West Indies.

PECULIAR, signifies a particular parish or church that hath jurisdiction within itself, for probate of wills, &c. exempt from the ordinary, and the bishop's court. The Court of Peculiars is that which deals in certain parishes, lying in several dioceses; which parishes are exempt from the jurisdiction of the bishops of those dioceses, and are peculiarly belonging to the Archbishop of Canterbury, within whose province there are fifty-seven such peculiars.

PEDALIUM, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Luridæ. Bignoniæ, Jussieu. Essential character: calyx five-parted; corolla subringent, with a five-cleft border; nut suberous, four-cornered, thorny at the corners, two-celled; seeds two. There is but one species, *viz.* P. murex, prickly-fruited pedalium: it is a native of the East Indies.

PEDALS, the largest pipes of an organ, so called because played and stopped with the foot. The pedals are made square, and of wood; they are usually thirteen in number. They are of modern invention, and serve to carry the sounds an octave deeper than the rest. See ORGAN.

PEDESTAL, in architecture, the lowest part of an order of columns, being that which sustains the column, and serves it as a foot or stand. The pedestal consists of three principal parts, *viz.* a square trunk, or dye, which makes the body; a corniche, the head; and a base, the foot of the pedestal. There are as many kinds of pedestals as there are of orders of columns, *viz.* the Tuscan, Doric, Ionic, Corinthian, and Composite. See ARCHITECTURE.

PEDESTALS *of statues*, are such as serve to support statues or figures. Vignola observes, that there is no part of architecture more arbitrary, and in which more liberty may be taken, than in the pedestals of statues; there being no rules or laws prescribed by antiquity, nor any settled even by the moderns. There being then no fixed proportion for these pedestals, the height depends on the situation, and the figure that they sustain: when on the ground, the pedestal is usually two-thirds or two-fifths of that of the statue; the more massive the statue is, the stronger the pedestal must be. Their form and character, &c. are to be extraordinary and ingenious, far from the regularity and simplicity of the pedestals of columns. The same author gives a multiplicity of forms, as oval, triangular, multangular, &c.

PEDICELLARIA, in natural history, a genus of the Vermes Mollusca class and order. Body soft, and seated on a rigid, fixed peduncle; aperture single. Three species only are enumerated. P. globifera: head spherical; inhabits the Northern seas, among the spines of echini; body minute, and resembling a mucor; head reddish,

having the appearance of a small cherry; peduncle or stem tawny, and covered with a gelatinous hyaline skin. P. tridens: head three-lobed, the lobes oval and awned, neck round: this class inhabits the Northern Seas, among the spines of the echini: the neck is smooth and hyaline, sometimes reddish; lobes of the head sometimes four, and three times as long as the neck, rarely unarmed with awn; peduncle reddish, and three times as long as the neck.

PEDICELLUS, in botany, a partial flower stalk, or the proper stalk of any single flower, in an aggregate or head of flowers. The principal stalk, which supports all the flowers, is called the common flower-stalk: the stalk of each partial flower, if it has one, is syled the proper flower stalk, or "pedicellus."

PEDICULARIS, in botany, *louse-wort*, or *red-rattle*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx five cleft; capsule two-celled, mucronate, oblique; seeds coated. There are nineteen species.

PEDICULUS, in botany, a foot-stalk, so called by former botanists; but Linnæus has substituted, in its stead, "petrolus," for the foot-stalk of the leaves; and "pedunculus," for the foot-stalk of the flowers.

PEDICULUS, in natural history, the *louse*, a genus of insects, of the order Aptera. Generic character: mouth with a retractile, recurved sucker, without proboscis; no feelers; antennæ as long as the thorax; two eyes; abdomen depressed; legs six, formed for running. These live by extracting animal juices; the larvæ and pupæ are six-footed, and nimble, resembling the perfect insect. There are between seventy and eighty species: of these some infest the bodies of quadrupeds, others of birds, and some even of insects themselves. P. humanus, or common louse, is distinguished by its pale, livid colour, and lobated, oval abdomen. It is produced from a small oval egg, popularly called by the name of a nit, which is fastened or agglutinated by its smaller end to the hair on which it is deposited: from this egg proceeds the insect, complete in all its parts, and only different from the parent animal in its smaller size. When examined by the microscope, it is seen, that the trunk or proboscis, which is generally concealed in its sheath or tube, is of a very sharp form, and is furnished towards the upper part with a few reversed aculei or prickles; the eyes are large, smooth, and black; the stomach and intestines afford a very distinct view of the peristaltic motion; the legs are each terminated by a double claw, not very much unlike that of a lobster, but of a sharper form; and the whole animal is every where covered by a strong granulated skin. Few insects are more prolific than the louse. It is said, that in about eight weeks a louse might see five thousand of its own descendants.

PEDIMENT, in architecture, is a kind of low pinnacle, serving to crown an ordonnance, or finish a frontispiece, and is placed as an ornament over gates, doors, windows, niches, altars, &c. being ordinarily of a triangular form, but sometimes forming an arch of a circle.

PEDOMETER. See PERAMBULATOR.

PEDUNCULUS, in botany, the foot-stalk of a flower, or head of flowers: the pedunculus elevates the flower and fruit only, without the leaves; the petiolus, or leaf-stalk, supports the leaves only, without the flower or fruit. Flower-stalks have different epithets, from the place which they occupy on the plant. When they proceed from the root, they are termed radicles; when from the stem, trunk-stalks; and when from the branch, branch stalks. They sometimes afford excellent characters in discriminating the species: an example is found in a species of the globe amaranth, which is distinguished by its flower-stalks being furnished with two leaves that are placed opposite, and immediately under each head of flowers.

PEEK, in the sea-language, is a word used in various senses: thus, the anchor is said to be a-peek, when the ship, being about to weigh, comes over her anchor in such a manner, that the cable hangs perpendicularly betwixt the hawse and the anchor. To heave a-peek, is to bring the peek so as that the anchor may hang a-peak. A ship is said to ride a-peak, when, lying with her main and fore yards hoisted up, one end of her yards is brought down to the shrouds, and the other raised up an end, which is chiefly done when she lies in rivers, lest other ships falling foul of the yards should break them. Riding a-broad peek, denotes much the same, excepting that the yards are only raised to half the height.

PEER, in general, signifies an equal, or one of the same rank and station: hence, in the acts of some councils, we find these words, with the consent of our peers, bi-

shops, abbots, &c. Afterwards the same term was applied to the vassals or tenants of the same lord, who were called peers, because they were all equal in condition, and obliged to serve and attend him in his courts; and peers in fiefs, because they all held fiefs of the same lord. The term peers is now applied to those who are impannelled in an inquest upon a person for convicting or acquitting him of any offence laid to his charge; and the reason why the jury is so called, is, because by the common law, and the custom of this kingdom, every person is to be tried by his peers, or equals, a lord by the lords, and a commoner by commoners. See JURY.

PEER *of the realm*, a noble lord who has a seat and vote in the House of Lords, which is also called the House of Peers. These lords are called peers, because, though there is a distinction of degrees in our nobility, yet in public actions they are equal, as in their votes in Parliament, and in trying any nobleman, or other person impeached by the Commons, &c. See PARLIAMENT.

All the peers who have a right to sit and vote in Parliament, are to be summoned at least twenty days before the trial of a peer, indicted for treason or felony: the method of proceeding in which, is, after the indictment is found, the King, by commission under the great seal, appoints one of the peers, and generally the Lord Chancellor, to be Lord High Steward, who in these cases sits as judge. In order to bring the indictment before him, a certiorari is issued out of the Court of Chancery; and another writ also issues for bringing up the prisoner, a precept being made for that purpose by the Lord High Steward, assigning a day, and the place of trial, and for summoning the peers, twelve of whom are at least to be present, and as many more as choose to be present. The day of trial being come, and the Lord High Steward being seated in his usual state, after the commission is read, and the particular ceremonies are over, his lordship declares to the prisoner at the bar, the cause of their assembly, assures him of justice, and at the same time encourages him to answer without fear; on which the indictment is read over, and the prisoner arraigned; when, after hearing all the evidence produced for the King, and the prisoner's answer, the prisoner is ordered to withdraw from the bar, when the lords go to some place by themselves, to consider of the evidence; and afterwards, being returned in order to give their verdict, the Lord High Steward openly demands of the lords, one by one, beginning with the puisne lord, whether the prisoner, calling him by his name, be guilty of the crime for which he is arraigned; when, laying their right hand upon their left breast, they separately answer, either guilty, or not guilty, upon their honour; and if he be found guilty by a majority of votes more than twelve, he is brought to the bar again, when the Lord High Steward acquaints the prisoner with the verdict of his peers, and passes sentence and judgment accordingly. It has been adjudged, that where such trial is by commission, as above, the Lord High Steward, after a verdict given, may take time to advise upon it, and his office continues till he passes judgment.

A peer is not to be put upon any inquest, even though the cause has a relation to two peers; but in trials where any peer is either plaintiff or defendant, there must be two or more knights returned on the jury. Where a peer is defendant in a court of equity, he is not to be sworn to his answer, but it may be upon his honour, as in the trial of peers: however, when a peer is to answer to interrogatories, or to make an affidavit, or is to be examined as a witness, he is to be sworn.

PEERESS, a woman who is noble by descent, creation, or marriage. If a peeress, by descent or creation, marries a person under the degree of nobility, she still continues noble; but if she obtains that dignity only by marriage, she loses it on her afterwards marrying a commoner; yet, by the courtesy of England, she always retains the title of her nobility. No peeress can be arrested for debt or trespass; for though, on account of their sex, peeresses cannot sit in the House of Lords, yet they enjoy the privileges of peers, and therefore all peeresses by birth, are to be tried by their peers.

PEGANUM, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Multisilique. Rutaceæ, Jussieu. Essential character: calyx five-leaved, or none; corolla five petalled; capsule three-celled, three-valved, many-seeded. There are two species, viz. P. harmala, a native of Spain, and P. dauricum, a native of Siberia.

PEGASUS, in astronomy, a constellation of the northern hemisphere, in form of a flying horse.

PEGASUS, in natural history, a genus of fishes of the order Cartilaginei. Generic

character: snout elongated; mouth beneath; pectoral fins large; ventral fins single-rayed; body compressed downwards, mailed; abdomen divided with bony segments. There are three species. P. draco is found in the seas of India, and is about three inches long, and distinguished by having its pectoral fins of so extraordinary a size, that it is enabled by them to maintain a short flight on the surface of the water: in this respect resembling the exocœti, and several other fishes. The two other species are also found in the Indian Seas.

PELARGONIUM, in botany, *crane's bill*, a genus of the Monadelphia Heptandria class and order. Natural order of Gruinales. Gerania, Jussieu. Essential character: calyx five-parted, the upper segment ending in a capillary, nectariferous tube, running along the peduncle; corolla five-petalled, irregular; filaments ten, unequal, three of which are castrated; fruit five-grained, beaked; beak spiral, bearded within. There are eighty-two species; almost all of them are natives of Africa, particularly those which are shrubby, come from the Cape of Good Hope.

PELECANUS, the *pelican*, in natural history, a genus of birds of the order Anseres. Generic character: bill straight, hooked at the point; nostrils in an almost obliterated furrow; face almost naked of feathers; gullet naked, and capable of great distention; four toes, all webbed together. There are thirty species, of which we shall notice the following:

P. onocrotalus, or the great pelican, is sometimes of the weight of twenty-five pounds, and of the width, between the extreme points of the wings, of fifteen feet; the skin, between the sides of the upper mandible, is extremely dilatable, reaching more than half a foot down the neck, and capable of containing many quarts of water. This skin is often used by sailors for tobacco-pouches, and has been occasionally converted into elegant ladies' work-bags. About the Caspian and Black Seas, these birds are very numerous, and they are chiefly to be found in the warmer regions, inhabiting almost every country of Africa. They build in the small isles of lakes, far from the habitations of man. The nest is a foot and a half in diameter, and the female, if molested, will remove her eggs into the water till the cause of annoyance is removed, returning them then to her nest of reeds and grass. These birds, though living principally upon fishes, often build in the midst of desarts, where that element is rarely to be found. They are extremely dexterous in diving for their prey, and after having filled their pouch, will retire to some rock, and swallow what they have taken at their leisure. They are said to unite with other birds in the pursuit of fishes. The pelicans dive, and drive the fish into the shallows. The cormorants assist, by flapping their wings on the surface, and forming a crescent, perpetually contracting, they at length accomplish their object, and compel vast numbers into creeks and shallows, where they gratify their voracity with perfect ease, and to the most astonishing excess.

P. occidentalis, or the American pelican, is about the size of a goose: of this bird it is reported, that it will bring supplies of food to any disabled and diseased companion; and that the natives of the island of Assumption, by confining one near the shore, frequently induce others to make these generous presents, which are fraudulently converted to the purpose of food for the islanders.

The red-backed pelican. One of these was in the possession of Mr. Latham, and was found, on an experiment purposely made, to store away ten fishes, weighing a pound each, in its pouch, arranging them with the head towards the throat. It then marched away to swallow them at its leisure; the pouch being extended nearly down to its feet.

P. aquilus, or the man of war bird, is small in body, but between the extremities of the wings fourteen feet in width. It is seldom seen but within the tropics, and not unfrequently is observed two hundred leagues from land. It watches the movements of fishes from a very considerable height, and pounces upon them with unfailing success, returning from its immersion with equal rapidity. It also often obliges other birds to quit the prey which they have just made, and are flying off with, and seizes it as it drops from them with a dexterity truly admirable. During the movements of flying fishes over the surface of the sea, which are previously indicated to this bird by the bubbling of the water: it is one of their most vigilant and fatal enemies.

P. carbo, or cormorant, is nearly as large as a goose, is found in many places both of the old and the new world, and is to be met with in the northern parts of this island, and one of them was, not very long since, shot as it was perched on the Castle of Car-

isle. These birds are shy and crafty, but frequently eat to so great an excess as to induce a species of lethargy, in which they are caught by nets thrown over them without their making an effort to escape. They are trained by the Chinese to fish for them. By a ring placed round their necks, they are prevented from swallowing what they take, and, when their pouches are filled, they unload them, and at the command of their owners, renew their divings: two will be seen combining their efforts to secure a fish, too large for the management of one only. When their work is finished to the employer's satisfaction, the birds have a full allotment of the spoil, for their reward and encouragement. In Macao, also, these birds are thus domesticated, taking extreme delight in the exercise, and constituting a source of very considerable profit to their owners. They were formerly trained, and used in the same manner in England; and Charles I. had an officer of his household, called master of the cormorants. See Aves, Plate XI. fig. 3.

P. bassanus, or the island-goose, or gannet, weighs about seven pounds, and inhabits, in great numbers, the northern isles of this kingdom. It is migratory, and drawn to this country by the shoals of herrings and pilchards, whose movements it watches with the most anxious vigilance. The young birds are sold in great plenty at Edinburgh, where they are frequently introduced before dinner as a stimulus to appetite. In St. Kilda, it is supposed that upwards of twenty thousand of these birds are taken annually. They constitute an important article of food to the inhabitants, who, to procure both the eggs and the young ones, expose themselves to the most imminent dangers on elevated and precipitous cliffs, and, in several instances have fallen victims to the hardihood with which they have pursued their researches. See Aves, Plate XI. fig. 4.

PELECOIDES, in geometry, a figure in form of an hatchet: such is the figure B C D A, Plate XII. Miscel. fig. 7, contained under the two inverted quadrantal arcs, A B, and A D, and the semi-circle, B C D. The area of the pelecoides is demonstrated to be equal to the square, A C, and that again to the parallelogram, E B. It is equal to the square, A C, because it wants of the square on the left hand the two segments, A B, and A C, which are equal to the two segments, B C, and C D, by which it exceeds on the right hand.

PELICAN. See Pelecanus.

PELLETS, in heraldry, are those roundles that are black, called also ögresses and gun-stones, and by the French torteaux de sable.

PELTA, in botany, a term by which the flower or flat fructification of the genus lichen or lever-wort is characterized, which, in most of its species, is glued to the edges of the leaves.

PELTARIA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosa. Cruciformes or Cruciferæ. Essential character: silicle entire, suborbiculate, compressed, flat, not opening. There are two species, viz. P. alliacea, garlick scented peltaria, and P. capensis, cape peltaria.

PELVIS, in anatomy, the lower part of the cavity of the abdomen, thus called from its resemblance to a bason, or ewer, in Latin called pelvis. It is formed by the ossa ilium and ischia, the os sacrum, the os coccygis, and the ossa pubis. See Anatomy.

PEN, *fountain*, is a pen made of silver, brass, &c. contrived to contain a considerable quantity of ink, and let it flow out by gentle degrees, so as to supply the writer a long time without being under the necessity of taking fresh ink.

PENÆA, in botany, so named from Peter Pena, a genus of the Tetrandria Monogynia class and order. Essential character: calyx two-leaved; corolla bell-shaped; style quadrangular; capsule four-cornered, four-celled, eight-seeded. There are nine species; these are shrubs which are rugged below, with the vestiges of fallen leaves, leafy above; leaves opposite, crosswise, sessile, approximating imbricately in a fourfold row, the upper ones near the flowers, like scales, and coloured; flowers terminating, sessile, solitary, or several together; fruit as in the order of Acanthi, but four-celled; this genus may perhaps be allied to them, but having been hitherto little examined, except in dried specimens, the natural order of the genus Penæa must yet remain uncertain. Jussieu.

PENAL *Laws* or *Statutes*, having been made on many occasions, to punish and deter offenders, they ought to be construed strictly, and not be extended by equity, but the words of them may be interpreted beneficially according to the intent of the legislator.

PENALTY, is a forfeiture inflicted for

not complying with the regulations of certain acts of parliament; a penalty is also annexed to secure the performance of certain covenants in a deed, articles of agreement, copartnership, &c. In a bond also for payment of money, it is usual to annex a penalty in double the amount of the obligation. See Bond.

PENCIL, an instrument used by painters for laying on their colours. Pencils are of various kinds, and made of various materials; the larger sorts are made of boars bristles, the thick ends of which are bound to a stick, bigger or less according to the uses they are designed for; these, when large, are called brushes. The finer sorts of pencils are made of camels, badgers, and squirrels hair, and of the down of swans; these are tied at the upper end with a piece of strong thread, and inclosed in the barrel of a quill. All good pencils on being drawn between the lips come to a fine point.

Pencil is also an instrument used in drawing, writing, &c. made of long pieces of black-lead, or red-chalk, placed in a groove cut in a slip of cedar, on which other pieces of cedar being glued, the whole is planed round, and one of the ends being cut to a point, it is fit for use.

PENDANT, an ornament hanging at the ear, frequently consisting of diamonds, pearls, and other precious stones.

Pendants, in heraldry, parts hanging down from the label, to the number of three, four, five, or six at most, resembling the drops in the Doric frieze. When they are more than three, they must be specified in blazoning.

Pendants, of a ship, are those streamers or long colours which are split and divided into two parts ending in points, and hung at the head of masts, or at the yard-arm ends.

PENDULOUS, a term applied to any thing that bends or hangs downwards; thus, the flowers, whose slender stalks are not able to sustain their heads upright, are called pendulous flowers. See Botany and Flower.

PENDULUM, in mechanics, denotes any heavy body, so suspended as that it may vibrate or swing backwards and forwards, about some fixed point, by the force of gravity. The vibrations of a pendulum are called its oscillations. See Oscillation. A pendulum, therefore, is any body. B, (Plate XII. Miscell. fig. 8), suspended upon, and moving about a fixed point, A, as a centre. The nature of a pendulum consists in the following particulars: 1. The times of the vibrations of a pendulum, in very small arches, are all equal. 2. The velocity of the bob, in the lowest point, will be nearly as the length of the chord of the arch which it describes in the descent. 3. The times of vibration in different pendulums, A B, A C, are as the square roots of the times of their vibrations. 4. The time of one vibration is to the time of the descent, through half the length of the pendulum, as the circumference of a circle to its diameter. 5. Whence the length of a pendulum, vibrating seconds, will be found 39.2 inches nearly; and that of an half second pendulum 9.8 inches. 6. An uniform homogeneous body B G (fig. 9) has a rod, staff, &c. which is one-third part longer than a pendulum A D, will vibrate in the same time with it.

From these properties of the pendulum we may discern its use as an universal chronometer, or regulator of time, as it is used in clocks, and such-like machines. See Chronometer, Horology, &c.

By this instrument also we can measure the distance of a ship, by measuring the interval of time between the fire and the sound of the gun; also the distance of a cloud, by numbering the seconds, or half-seconds, between the lightning and thunder. Thus, suppose between the lightning and thunder, we number 10 seconds; then, because sound passes through 1142 feet in one second, we have the distance of the cloud equal to 11420 feet. Again, the height of any room, or other object, may be measured by a pendulum vibrating from the top thereof. Thus, suppose a pendulum from the height of a room vibrates once in three seconds; then say, as 1 is to the square of 3, viz. 9, so is 39.2 to 352.8 feet, the height required. Lastly, by the pendulum we discover the different force of gravity on different parts of the earth's surface, and thence the true figure of the earth.

When pendulums were first applied to clocks, they were made very short; and, the arches of the circle being large, the time of vibration through different arches could not in that case be equal; to effect which, the pendulum was contrived to vibrate in the arch of a cycloid, by making it play between two semi-cycloids C B, C D (fig. 10), whereby it describes the cycloid B E A D; the property of which curve is, that a body vibrating in it will describe all its arches, great or small, in equal times.

These are, however, which concur in rendering the application of this curve to the vibration of pendulums designed for the measures of time, the source of errors even greater than those which by its peculiar property it is intended to obviate, and it is now not used.

Although the times of vibration of a pendulum in different arches be nearly equal, yet if the arches differ very considerably, the vibrations will be performed in different times, and the difference, though very small, will become sensible in the course of one day or more. In clocks for astronomical purposes, the arc of vibration must be accurately ascertained, and if it be different from that described by the pendulum when the clock keeps time, a correction must be applied to the time shown by the clock. This correction, expressed in seconds of time, will be equal to the half of three times the difference of the square of the given arc, and of that of the arc described by the pendulum when the clock keeps time, these arcs being expressed in degrees; and so much will the clock gain or lose according as the first of these arches is less or greater than the second. Thus, if a clock keeps true time when the pendulum vibrates in an arch of 3°, it will lose $10\frac{1}{2}$ seconds daily in an arch of 4°, and 24 seconds in an arc of 5° for $\overline{4^2 - 3^2} \times \frac{3}{2} = 7 \times \frac{3}{2} = 10\frac{1}{2}$ and generally $\overline{B^2 - A^2} \times \frac{3}{2}$ gives the time lost or gained. See Simpson's Fluxions, vol. ii. prob. xxviii.

In all that has been hitherto said, the power of gravity has been supposed constantly the same. But, if the said power varies, the lengths of pendulums must vary in the same proportion, in order that they may vibrate in equal times; for we have shewn, that the ratio of the times of vibration and descent through half the lengths is given, and consequently the times of vibration and descent through the whole length is given; but the times of vibration are supposed equal, therefore the times of descent through the lengths of the pendulum are equal. But bodies descending through unequal spaces, in equal times, are impelled by powers that are as the spaces described, that is, the powers of gravity are as the lengths of the pendulums.

Pendulums' length in latitude of London, to swing.

	Inches.
Seconds............	39.2
½ Seconds..............	9.8
¼ Seconds..............	2.45

Length of Pendulums to vibrate Seconds at every Fifth Degree of Latitude.

Degrees of Latitude.	Length of Pendulum.	Degrees of Latitude.	Length of Pendulum.	Degrees of Latitude.	Length of Pendulum.
	Inches.		Inches.		Inches.
0	39.027	35	39.084	65	39.168
5	39.029	40	39.097	70	39.177
10	39.032	45	39.111	75	39.185
15	39.036	50	39.126	80	39.191
20	39.044	55	39.142	85	39.195
25	39.057	60	39.158	90	39.197
30	39.070				

Rule. To find the length of a pendulum to make any number of vibrations, and *vice versa*. Call the pendulum making 60 vibrations the standard length; then say, as the square of the given number of vibrations is to the square of 60; so is the length of the standard to the length sought. If the length of the pendulum be given, and the number of vibrations it makes in a minute be required; say, as the given length is to the standard length, so is the square of 60, its vibrations in a minute, to the square of the number required. The square root of which will be the number of vibrations made in a minute.

The greatest inconvenience attending this most useful instrument is, that it is constantly liable to an alteration of its length, from the effects of heat and cold, which very sensibly expand and contract all metalline bodies. See HEAT, PYROMETER, &c.

To remedy this inconvenience, the common method is by applying the bob of the pendulum with a screw; so that it may be at any time made longer or shorter, according as the bob is screwed downwards or upwards, and thereby the time of its vibrations kept always the same. Again, if a glass or metalline tube, uniform throughout, filled with quicksilver, and 58.8 inches long, were applied to a clock, it would vibrate seconds for $39.2 = \frac{2}{3}$ of 58.8, and such a pendulum admits of a twofold expansion and contraction, *viz.* one of the metal and the other of the mercury, and these will be at the same time contrary, and therefore will correct each other. For by what we have shewn, the metal will extend in length with heat, and so the pendulum will vibrate slower on that account. The mercury also will expand with heat, and since by this expansion it must extend the length of the column upward, and consequently raise the

centre of oscillation; so that by this means its distance from the point of suspension will be shortened, and therefore the pendulum on this account will vibrate quicker; wherefore, if the circumstances of the tube and mercury are skilfully adjusted, the time of the clock might, by this means, for a long course of time, continue the same, without any sensible gain or loss. This was the invention of Mr. Graham, in the year 1721, who made a clock of this sort, and compared it with one of the best of the common sort for three years together, and found the errors of the former but about one-eighth part of the latter.

Mr. Graham also made a pendulum consisting of three bars, one of steel between two of brass, and the steel bar acted upon a lever, so as to raise the pendulum, when lengthened by heat, and to let it down, when shortened by cold; but he found this clock liable to sudden starts and jerks in its motion.

The ingenious Mr. Ellicott, in the Transactions of the Royal Society, describes a pendulum of his invention, composed of brass and iron, with the method of applying it, so as to avoid the many jerks to which the machine might be liable.

But besides the irregularities arising from heat and cold, pendulum clocks are liable to others from friction and foulness; to obviate which, Mr. Harrison has several excellent contrivances, whereby his clocks are almost entirely free from friction, and never need to be cleaned. See LONGITUDE.

The gridiron pendulum is a contrivance for the same purpose. Instead of one rod, this pendulum is composed of any convenient odd number of rods, as five, seven, or nine; being so connected, that the effect of one set of them counteracts that of the other set; and therefore, if they are properly adjusted to each other, the centres of suspension and oscillation will always be equidistant. Fig. 11 represents a gridiron pendulum composed of nine rods, steel and brass alternately. The two outer rods, A B, C D, which are of steel, are fastened to the cross pieces A C, B D by means of pins. The next two rods, E F, G H, are of brass, and are fastened to the lower bar B D, and to the second upper bar E G. The two following rods are of steel, and are fastened to the cross bars E G and I K. The two rods adjacent to the central rod being of brass, are fastened to the cross pieces I K and L M; and the central rod, to which the ball of the pendulum is attached, is suspended from the cross piece L M, and passes freely through a perforation in each of the cross bars I K, B D. From this disposition of the rods, it is evident that, by the expansion of the extreme rods, the cross piece B D, and the two rods attached to it, will descend: but since these rods are expanded by the same heat, the cross piece E G will consequently be raised, and therefore also the two next rods; but because these rods are also expanded, the cross bar I K will descend: and by the expansion of the two next rods, the piece L M will be raised a quantity sufficient to counteract the expansion of the central rod. Whence it is obvious, that the effect of the steel rods is to increase the length of the pendulum in hot weather, and to diminish it in cold weather, and that the brass rods have a contrary effect upon the pendulum. The effect of the brass rods must, however, be equivalent not only to that of the steel rods, but also to the part above the frame and spring, which connects it with the cock, and to that part between the lower part of the frame and the centre of the ball.

Another excellent contrivance for the same purpose is described in a French author on clock-making. It was used in the north of England by an ingenious artist about fifty years ago. This invention is as follows: a bar of the same metal with the rod of the pendulum, and of the same dimensions, is placed against the back-part of the clock-case: from the top of this a part projects, to which the upper part of the pendulum is connected by two fine pliable chains or silken strings, which just below pass between two plates of brass, whose lower edges will always terminate the length of the pendulum at the upper end. These plates are supported on a pedestal fixed to the back of the case. The bar rests upon an immoveable base at the lower part of the case; and is inserted into a groove, by which means it is always retained in the same position. From this construction, it is evident that the extension or contraction of this bar, and of the rod of the pendulum, will be equal, and in contrary directions. For suppose the rod of the pendulum to be expanded any given quantity by heat; then, as the lower end of the bar rests upon a fixed point, the bar will be expanded upwards, and raise the upper end of the pendulum just as much as its length was increased; and hence its length below the plates will be the same as before. Of this

pendulum, somewhat improved by Mr. Crosthwaite, watch and clockmaker, Dublin, we have the following description, "A and B (fig. 12), are two rods of steel forged out of the same bar, at the same time, of the same temper, and in every respect similar. On the top of B is formed a gibbet C; this rod is firmly supported by a steel bracket D, fixed on a large piece of marble E, firmly set into the wall F, and having liberty to move freely upwards between cross staples of brass, 1, 2, 3, 4, which touch only in a point in front and rear (the staples having been carefully formed for that purpose); to the other rod is firmly fixed by its centre the lens G; of twenty-four pounds weight, although it should in strictness be a little below it. This pendulum is suspended by a short steel spring on the gibbet at C: all which is entirely independent of the clock. To the back of the clock-plate, I, are firmly screwed two cheeks nearly cycloidal at K, exactly in a line with the centre of the verge L. The maintaining power is applied by a cylindrical steel-stud, in the usual way of regulators at M. Now, it is very evident, that any expansion or contraction that takes place in either of these exactly similar rods, is instantly counteracted by the other; whereas in all compensation pendulums composed of different materials, however just the calculation may seem to be, that can never be the case, as not only different metals, but also different bars of the same metal, that are not manufactured at the same time, and exactly in the same manner, are found by a good pyrometer to differ materially in their degrees of expansion and contraction, a very small change affecting one and not the other." The expansion or contraction of straight-grained fir-wood lengthwise, by change of temperature, is so small, that it is found to make very good pendulum rods. The wood called sapadillo is said to be still better. There is good reason to believe, that the previous baking, varnishing, gilding, or soaking of these woods in any melted matter, only tends to impair the property that renders them valuable. They should be simply rubbed on the outside with wax and a cloth. In pendulums of this construction the error is greatly diminished, but not taken away.

PENGUIN. See Aptenodytes.

PENELOPE, in natural history, a genus of birds of the order Gallinæ. By Latham, they are mostly arranged under the genus Meleagris, or the Turkey. Their legs, however, are without spurs. They inhabit principally South America, and particularly Brasil and Guiana. The P. cristata, or guan, is two feet six inches in length. P. cumanensis, or the yacou, is of the size of a hen turkey, and is found in Cayenne and Guiana. The Marail is found in flocks in Guiana, feeds on fruits, and roosts on trees. See Aves, Plate XI. fig. 5.

PENIS. See Anatomy.

PENNANTIA in botany, so named in honour of Thomas Pennant, a genus of the Polygamia Dioecia, class and order. Essential character: calyx, none; corolla five petalled; stamens five: pericarpium, three sided, two-celled, with solitary subtriquetrous seeds. There is but one species, *viz.* P. corymbosa, a native of New Zealand.

PENNATULA, in natural history, *sea-pen*, a genus of the Vermes Zoophyta class and order; animal not affixed, of various shapes, supported by a bony part within, naked at the base, the upper part with generally lateral ramifications, furnished with rows of tubular denticles producing radiate polypes from each tube. There are about eighteen species, of which P. coccinea is described as: stem round, radiating, with papillous polype-bearing sides, and clavate at the top. It is found in the White Sea, is soft, red, an inch and a half high, and as thick as the little finger, wrinkled, with the papillæ disposed in rows. P. phosphorea has a fleshy stem, with a rough midrib, and imbricate ramification. It inhabits most seas, and emits a very strong phosphoric light in the dark; about four inches long, red, stem villous, with a lanceolate rough midrib, and nearly incumbent rays, the tubes pointing all one way. P. reniformis; stem round, vermicular, supporting a kidney-shaped leaf-like head, producing polypes on one surface. It inhabits South Carolina: body expanded, kidney-shaped, flat, rising from a short round stem, and covered on the upper surface with numerous tubular orifices, through which the polypes are obtruded at pleasure; the upper surface is of a rich purple, the under side brilliant, and sometimes yellowish.

PENNY, an ancient silver coin, which, though now little used, was the only one current among our Saxon ancestors. It was then equal to $\frac{1}{240}$th part of a pound. In Etheldred's time the penny was the 20th part of the Troy ounce, hence the denomination penny-weight. Till the time of Edward the first, the penny was struck with a cross

so deeply sunk into it, that it might on occasion be easily broken, and parted into halves and quarters, hence the term halfpence, and farthings or four things. We have now copper pence, which are much used in the way of change. They are manufactured by Mr. Bolton, and are very handsome coins.

PENNY *weight*, a Troy-weight, containing twenty-four grains, each of which is equal in weight to a grain of wheat, gathered out of the middle of the ear, and well dried.

PENSION, no person having a pension from the crown, during pleasure, or for any term of years, is capable of being elected a member of the House of Commons. To receive a pension from a foreign prince or state, without leave of the king, has been held to be criminal, because it may incline a man to prefer the interest of such foreign prince to that of his own country.

PENSIONER, in general, denotes a person who receives a pension, yearly salary, or allowance. Hence,

The band of gentlemen-pensioners, the noblest sort of guard to the king's person, consists of forty gentlemen, who receive a yearly pension of one hundred pounds. This honourable band was first instituted by King Henry VIII, and their office is to attend the King's person, with their battle-axes, to and from his chapel-royal, and to receive him in the presence chamber, or coming out of his privy-lodgings: they are also to attend at all great solemnities, as coronations, St. George's feast, public audiences of embassadors, at the sovereign's going to parliament, &c.

They are each obliged to keep three double horses and a servant, and so are properly a troop of horse. They wait half at a time, quarterly; but on Christmas-day, Easter-day, Whitsunday, &c. and on extraordinary occasions, they are all obliged to give their attendance. They have likewise the honour to carry up the sovereign's dinner on the coronation-day, and St. George's feast; at which times, the King or Queen usually confer the honour of knighthood on two such gentlemen of the band as their captain presents. Their arms are gilt battle-axes; and their weapons, on horse-back, in time of war, are curassiers-arms, with sword and pistols. Their standard, in time of war, is, argent, a cross gules. Their captain is always a nobleman, who has under him a lieutenant, a standard-bearer, a clerk of the check, secretary, paymaster, and harbinger.

PENSTOCK, a sluice, or flood-gate, serving to retain or let go, at pleasure, the water of a mill-pond, or the like.

PENTACHORD, an ancient musical instrument, with five strings, whence the name.

PENTAGON, in geometry, a figure of five sides and five angles. If the five sides be equal, the angles are so too, and the figure called a regular pentagon.

The most considerable property of a pentagon is, that one of its sides is equal in power to the sides of a hexagon and a decagon, inscribed in the same circle; that is, the square of the side of the pentagon is equal to the sum of the squares of the sides in the other two figures. The area of a pentagon, like that of any other polygon, may be obtained by resolving it into triangles. Pappus has also demonstrated that twelve regular pentagons contain more than twenty triangles inscribed in the same circle. The dodecahedron, which is the fourth regular solid, consists of twelve pentagons. In fortification, pentagon denotes a fort with five bastions.

PENTAGRAPH, an instrument whereby designs of any kind may be copied in what proportion you please, without being skilled in drawing. (Plate Pentagraph, fig. 1), is a plan of a pentagraph, and (fig. 2 and 3), part of the same on a larger scale.

The pentagraph is made of brass, and consists of four levers A B D E, the two longest, A B, are jointed together at their ends, the other two, D E, are also jointed together at one of their ends, and to the levers A B at the others. In this manner the instrument always forms a parallelogram, $a\,A\,a = e\,E\,e$ and $a\,B\,e = a\,D\,e$; f, g, and h, are three tubes upon the levers, two of which, f, g, slide along upon their respective levers, and can be fixed at any point by screws (one of these tubes is shewn separately in fig. 3), any one of these tubes is adapted to receive either a fulcrum or fixed centre, round which the whole instrument turns a blunt point or tracer, to pass over the original design, which is to be copied; or a crayon to draw the figure, or copy of the original design; these three points must be always in one right line, and by the construction of the levers, if they are once set in a line, they will continue in it through any of its motions.

The proportion in which it will reduce any figure will be easily calculated from the same principles as the lever; that the mag-

nitude of the figures described by either of the points, will be in the same proportion to each other, as the distances of those points from the fulcrum, thus if the point *f* be the fulcrum, and if the distance from *f* to *g* be half the distance from *f* to *h*, the size of the figure described by the point *g* will be half the size of the figure described at the same time by the point *h*. The fulcrum, as we have said before, can be changed, as also the pencil and the tracer, and any of the three can be applied to either of the tubes upon the levers, if the tracer is placed in the tube *h*, the pencil in *g*, and the fulcrum at *f*, any figure described by the tracer *h*, will be exactly copied one half the size by the pencil at *g*, and if on the contrary the pencil is placed at *h*, and the tracer at *g*, the figure drawn by the pencil will be twice the size of the original traced at *g*.

When the fulcrum is placed between the two points at *g*, the figures described by each point will be inverted with respect to each other, though the same principle applies, that the magnitude of the figures, will bear the same proportion to each other, as the distances of their tracing point from the fulcrum bear to each other. This last position of the instrument is seldom used on account of the figure being inverted, except when the figures traced and copied are equal to each other, or nearly so, as the first position will not allow of that.

It will be easily seen that by the sliding motion of the tubes, *g* and *f*, the proportion between the three may be varied in any degree, and for this purpose the levers are engraved, and divisions made to set the tubes by, so as to reduce it in any proportion, and at the same time put the three points in the same right line, otherwise the figures will be strangely distorted; *n n n* is a silk thread, which the operator hooks round his fore finger, by pulling this he raises up the crayon, *g*, so that it will not mark; each joint of the instrument is formed by a short axis, *i*, (fig. 2), made fast and moving with one lever, *k*, it has pivots at its ends, working in a small cock, *l*, screwed to the upper side of the other lever: beneath each joint a small tube, *m*, is screwed, its upper end receives the lower pivot of the axis *i*, and in the lower part a small spindle, *n*, is fitted, which has a castor at the bottom to support the weight of the instrument, by the turning of the spindle *n* the castor will run in any direction. One of these castors is also fixed at the outer end of the levers, A and B, as well as beneath each joint. Care should be taken that the table, upon which the instrument is used, is a perfect plane, otherwise errors will arise from the tracer or crayon being sometimes thrown out of the perpendicular, and it is for the same reason that the levers are jointed with an axis as explained before.

Fig. 4, Plate Pentagraph, is the common parallel ruler, A B are two rulers connected by two bars C D, which are of equal lengths, and the distance between the pins by which the levers C D are fixed to the rulers, are the same distance from each other in both rulers, by this means it is easily seen, that the two rulers, A B, will always move parallel to each other.

Fig. 5, is another ruler differing from the other in being double; the advantage of it over fig. 4, is, that the two rulers A B can be moved parallel to each other without sliding endways, as the other does, every part of the moving ruler describing the arc of a circle.

PENTAMETER, in ancient poetry, a kind of verse consisting of five feet, or metres; whence the name. The two first feet may be either dactyls or spondees, at pleasure; the third is always a spondee, and the two last anapests: such is the following verse of Ovid.

1 2 3 4 5
Carmini | bus vi | ves tem | pus in o | mne meis.

A pentameter verse, subjoined to an hexameter, constitutes what is called elegiac.

PENTANDRIA, in botany, the name of the fifth class of plants in the Linnæan system, consisting of plants which have hermaphrodite flowers with five stamina. There are six orders in this class, founded upon the number of styles.

PENTAPETES, in botany, a genus of the Monadelphia Dodecandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer three leaved; inner five-parted; stamina fifteen, with five ligules, petal shaped; capsule five-celled, many-seeded. There is but one species, viz. P. phœnicea, scarlet flowered pentapetes, a native of the East Indies and Japan.

PENTHORUM, in botany, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: calyx five or ten cleft; petals none, or five; capsule five-cusped, five-celled. There is only one species, viz. P. sedoides, American penthorum.

PENTSTEMON, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Essential character: calyx five-leaved; corolla bilabiate, ventricose; rudiment of a fifth stamen bearded above; capsule two-celled. There are two species, viz. P. lævigata, smooth pentstemon, and P. pubescens, hairy pentstemon.

PENULTIMA, or *penultimate syllable*, in grammar, denotes the last syllable but one of a word; and hence the anti-penultimate syllable is the last but two, or that immediately before the penultima.

PENUMBRA, in astronomy, a partial shade observed between the perfect shadow and the full light in an eclipse. It arises from the magnitude of the sun's body; for were he only a luminous point, the shadow would be all perfect; but by reason of the diameter of the sun, it happens that a place which is not illuminated by the whole body of the sun, does yet receive rays from a part thereof. See ASTRONOMY.

PEPLIS, in botany, *purslane*, a genus of the Hexandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx bell-shaped, with a twelve-cleft mouth; petals six, inserted into the calyx; capsule two-celled. There are two species, viz. P. portula, water purslane, and P. tetrandria.

PEPPER, in natural history, an aromatic berry, of a hot dry quality, chiefly used in seasoning. See PIPER.

We have three kinds of pepper, at this time in use in the shops; the black, the white, and the long pepper.

Black pepper is the fruit of a plant of the Diandria Trigynia class, without any flower petals; the fruit itself is roundish and rugose, and disposed in clusters: it is brought from the Dutch settlements in the East Indies.

The common white pepper is factitious, being prepared from the black in the following manner: they steep this in sea water, exposed to the heat of the sun for several days, till the rind or outer bark loosens; they then take it out, and when it is half dry, rub it till the rind falls off; then they dry the white fruit, and the remains of the rind blow away like chaff. A great deal of the heat of the pepper is taken off by this process; so that the white kind is fitter for many purposes than the black. However, there is a sort of native white pepper, produced on a species of the same plant, which is much better than the factitious, and indeed little inferior to the black.

The long pepper is a dried fruit of an inch, or an inch and a half in length, and about the thickness of a large goose quill: it is of a brownish-grey colour, cylindrical in figure, and said to be produced on a plant of the same genus.

Pepper is principally used by us in food, to assist digestion; but the people in the East Indies esteem it as a stomachic, and drink a strong infusion of it in water by way of giving them an appetite: they have also a way of making a fiery spirit of fermented fresh pepper with water, which they use for the same purpose. They have also a way of preserving the common and long pepper in vinegar, and eating them afterwards at meals.

PEPPER *water*, a liquor prepared in the following manner, for microscopical observations: put common black pepper, grossly powdered, into an open vessel, so as to cover the bottom of it half an inch thick, and put to it rain or river water, till it covers it an inch; shake or stir the whole well together at the first mixing, but never disturb it afterwards: let the vessel be exposed to the air uncovered; and in a few days there will be seen a pellicle or thin skin swimming on the surface of the liquor, looking of several colours.

This is a congeries of multitudes of small animals; and being examined by the microscope, will be seen all in motion: the animals, at first sight, are so small as not to be distinguishable, unless to the greatest magnifiers; but they grow daily till they arrive at their full size. Their numbers are also continually increasing, till the whole surface of the liquor is full of them, to a considerable depth. When disturbed they will sometimes all dart down to the bottom, but they soon after come up to the surface again. The skin appears soonest in warm weather, and the animals grow the quickest; but in the severest cold it will succeed, unless the water freezes.

About the quantity of a pin's head of this scum, taken up on the nib of a new pen, or the tip of a hair pencil, is to be laid on a plate of clear glass; and if applied first to the third magnifier, then to the second, and finally to the first, will show the different animalcules it contains, of several kinds and shapes, as well as sizes.

PEPPERMINT, a species of mint. See MENTHA.

PERAMBULATOR, a machine for

measuring distances upon the ground. Its external figure is shewn in figs. 1 and 2, Plate Perambulator. A B is a mahogany wheel strongly framed and hooped with iron, that it may not wear, it turns in a handle, D E, which the operator holds in his hand, and thus wheels it along upon the ground. At F is a piece of mechanism to register the number of revolutions the wheel has made. The pivots of the wheel work into pieces of brass let into the two arms of the handle, D E; on the end of one of its pivots, a small pinion, *a*, (fig. 3) is fixed, this turns another pinion, *b*, upon a long spindle, *d*, which conveys the motion to the machinery at F (fig. 2); both pinions have eight teeth, therefore the spindle, *d*, turns in the same time as the great wheel, A B. This spindle is let into the wood work of the handle, as is shewn in the dotted line, *d* (fig. 2), and has a square hole in its end to receive the end of a short arbor, *e* (fig. 4), which is an enlarged plan of the wheel work; this end has an endless screw on it turning a wheel, *f*; below this wheel, on the same arbor, is a pinion turning a wheel, *h*, and lower still is another wheel (hidden by *f*), turning a pinion, *g*, on whose arbor is the small hand, *i*, shewn in the plan of the dial plate. The wheel, *h*, has a pinion on its arbor, immediately above it, turning *k*, which has pinion above it, turning *l*, whose arbor is a tube, and put over the orb of *h*; this tube has a short hand, *m* (fig. 5), fixed on it. The long hand, *n*, is fixed to the arbor of the wheel *h*; this arbor is not made fast to the wheel, but to a circular plate, *p*, against which the wheel fits, and to which it is held by a pin put through the arbor beneath it, by this means the hands can be turned round to set them without moving the wheel *h*; a pin is fixed in this wheel, which *a*, every revolution, lifts and lets fall a hammer, *r*, to strike the bell, *t*, and thus give notice of the hand having completed its revolution. The great wheel is half a pole in circumference, and the wheels, *a b*, being equal, the endless screw turns once for every half pole the instrument is wheeled along the ground; the screw is so cut that it turns the wheel, *f*, once in twenty-four turns of the great wheel equal twelve poles. The lower wheel on its arbor has thirty-six teeth, and turns *g*, of twelve teeth, three times as fast, or once for four poles; this is equal to one chain, and the circle of the hand, *i*, (fig. 5) which it carries, is divided into one hundred, each equal one link; the pinion on the arbor of *f* has twelve teeth, and *h*, which it turns, has forty, it will turn once for 3⅓ times of *f*, or 3⅓ times 12 poles = 40 poles = 1 furlong, the dial of the hand, *n*, which it carries, is divided into forty, each equal one pole, and by the pin in the plate, *p*, it strikes the bell once each revolution. The pinion of eight on the arbor of *h*, turns *k*, of sixty-four once for eight furlongs, and its pinion of six, drives *l* of seventy-two, once round for twelve of *k*, or ninety-six furlongs equal twelve miles. The hand, *m*, fixed to its arbor, points out these distances on a circle divided into twelve for miles, and subdivided into eight for furlongs. A small scraper is fixed to the frame to prevent the wheel gathering dirt, and thus enlarging its circumference.

In wheeling a machine along a road, care should be taken to avoid all sudden holes or hills as much as possible, without deviating from the straight line.

The bell, by striking, is of great use to point out every furlong which might otherwise be passed unnoticed.

PERCA, the *perch*, in natural history, a genus of fishes of the order Thoracici. Generic character: jaws unequal; teeth sharp and incurvated; gill-covers of three lamina, scaly and serrated; dorsal fin spiny on the fore part; scales generally hard and rough. There are sixty species, of which the following is most deserving of notice.

P. fluviatilis, or the common perch, is generally from one to two feet long, and two pounds and a half in weight, and inhabits the clear fresh waters of almost every country in Europe, sometimes attaining the weight of ten pounds. It is gregarious, haunts those parts where the stream is gentle and profound, is extremely rapacious, catches with avidity at almost any bait, and tenacious of vitality to an extraordinary degree, surviving a journey of fifty miles, though packed up in dry straw. It is highly valued both for its firmness and flavour, and among the Romans was held in very superior estimation.

PERCEPTION, in logic, the first and most simple act of the mind, whereby it perceives or is conscious of its ideas.

In bare perception, the mind is for the most part only passive; yet impressions made on the senses cause no perception, unless they are taken notice of by the mind, as we see in those who are intently busied in the contemplation of certain objects. It ought also to be observed, that the ideas

we receive by perception are often altered by the judgment, without our taking notice of it; so that we take that for the perception of our senses, which is but an idea formed by the judgment: thus a man who reads or hears, with attention, takes little notice of the characters or sounds, but of the ideas excited in him by them.

The faculty of perception seems to be that which constitutes the distinction between the animal kingdom and the inferior parts of nature. Perception is also the first step towards knowledge, and the inlet of all the materials of it; so that the fewer senses a man has, and the duller the impressions that are made by them are, the more remote he is from that knowledge which is to be found in other men.

PERCH, or PEARCH. See PERCA.

PERCH, a measure of length, equal to five yards and a half. See MEASURE.

PERCUSSION, in mechanics, the impression a body makes in falling or striking upon another, or the shock of two bodies in motion. See MOTION.

Percussion is either direct or oblique; direct, when the impulse is given in a line perpendicular to the point of contact; and oblique, when it is given in a line oblique to the point of contact. The ratio which an oblique stroke bears to a perpendicular one, is as the sine of the angle of incidence to the radius. Thus, let $a\,b$ (Plate XII. Miscel. fig. 13) be the side of any body on which an oblique force falls, with the direction $d\,a$; draw $d\,c$ at right angles to $d\,b$, a perpendicular let fall from d to the body to be moved, and make $a\,d$ the radius of a circle; it is plain that the oblique force $d\,a$, by the laws of composition and resolution of motions, will be resolved into the two forces $d\,c$ and $b\,d$; of which $d\,c$, being parallel to $a\,b$, hath no energy or force to move that body; and, consequently, $d\,b$ expresses all the power of the stroke or impulse on the body to be moved: but $d\,b$ is the right sine of the angle of incidence $d\,a\,b$; wherefore the oblique force $d\,a$, to one falling perpendicularly, is as the sine of the angle of incidence to the radius.

PERDICIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: corollets bilabiate; down simple; receptacle naked. There are six species.

PERENNIAL, in botany, is applied to those plants whose roots will abide many years, whether they retain their leaves in winter or not: those which retain their leaves are called ever-greens; but such as cast their leaves, are called deciduous. Some of these have annual stalks, which die to the root every autumn, and shoot up again in the spring.

PERFECT, in arithmetic. Perfect number is, that all whose aliquot parts added together, make the same number with the number whereof they are such parts. Thus six is a perfect number, being equal $1+2+3$: so also is $28=1+2+4+7+14$. Mathematicians have been at considerable pains to investigate the perfect numbers, but with no great success, the following are given as the first six perfect numbers:

6
28
496
8128
33550336
8589869056

PERGULARIA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; nectary surrounding the gentials with five sagittated cusps; corolla salver-shaped. There are five species.

PERIANTHIUM, in botany, the *flower-cup*, properly so called, the most common species of calyx, placed immediately under the flower, which is contained in it as a cup. The flower-cup differs in point, number, figure, proportion, and situation.

PERICARPIUM. See BOTANY.

PERICRANIUM, in anatomy, a thick solid coat, or membrane, covering the outside of the cranium or skull.

PERIGEE, in astronomy, that point of the sun's or moon's orbit, wherein they are at their least distance from the earth, in which sense it stands opposed to apogee.

PERIHELIUM, in astronomy, that point of a planet's or comet's orbit, wherein it is in its least distance from the sun; in which sense it stands in opposition to aphelium.

PERILLA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticellatæ. Labiatæ, Jussieu. Essential character: calyx, uppermost segment very short; stamens distant; styles two, connected. There is but one species; *viz.* P. ocymoides, an annual plant, and a native of the East Indies.

PERIMETER, in geometry, the bounds or limits of any figure or body. The peri-

meter of surfaces or figures are lines, those of bodies are surfaces. In circular figures, instead of perimeter, we say circumference, or periphery.

PERINÆUM, or PERINEUM. See ANATOMY.

PERIOD, in astronomy, the time taken up by a star or planet in making a revolution round the sun; or the duration of its course till it return to the same point of its orbit. See ASTRONOMY. There is a wonderful harmony between the distances of the planets from the sun, and their periods round him; the great law whereof is, that the squares of the periodical times of the primary planets, are to each other as the cubes of their distances from the sun; and likewise, the squares of the periodical times of the secondaries of any planet, are to each other as the cubes of their distances from that primary. This harmony among the planets is one of the greatest confirmations of the Copernican hypothesis.

PERIOD, in chronology, denotes a revolution of a certain number of years, or a series of years, whereby, in different nations, and on different occasions, time is measured; such are the following.

PERIOD, *Calippic*, a system of seventy-six years. The calippic period comprehends 48 common years, and 28 intercalary ones, 940 lunations, and 27,759 days. See CHRONOLOGY.

PERIOD, *Dionysian*, or *Victorian* PERIOD, a system of 532 lunæ-solar and Julian years, which being elapsed, the characters of the moon fall again upon the same day and feria, and revolve in the same order, according to the opinion of the ancients. This period is otherwise called the great paschal cycle, because the Christian church first used it, to find the true time of the pascha, or easter. The sum of these years arise by multiplying together the cycles of the sun and moon. See EASTER.

PERIOD, *Hipparchus's*, a system of 304 years, both lunar and solar, which being elapsed, Hipparchus thought that the reckoning by the lunar motion would coincide again with the solar measures. This period comprehends 3760 lunar months, or 111,039 days; the sum of which arises from the multiplication of the calippic period by 4, subtracting unity from the product.

PERIOD, in grammar, denotes a small compass of discourse, containing a perfect sentence, and distinguished at the end by a point, or full stop, thus (.); and its members or divisions marked by commas, colons, &c.

PERIOD is also used for the character (.) wherewith the periods of discourse are terminated, or expressed, being commonly called a full stop or point. See PUNCTUATION.

PERIOD, in numbers, a distinction made by a point, or comma, after every sixth place or figure; and is used in numeration for the readier distinguishing and naming the several figures or places, which see under ARITHMETIC.

PERIOECI, in geography, such inhabitants of the earth as have the same latitudes, but opposite longitudes; or live under the same parallel and the same meridian, but in different semicircles of that meridian, or in opposite points of the parallel. These have the same common seasons throughout the year, and the same phenomena of the heavenly bodies; but when it is noon-day with the one it is midnight with the other, there being twelve hours between them in an east or west direction. These are found on the globe, by the hour-index, or by turning the globe half round, that is 180 degrees either way.

PERIOSTEUM, or PERIOSTIUM, in anatomy, a nervous vasculous membrane, endued with a very quick sense, immediately surrounding in every part both the internal and external surfaces of all the bones in the body, excepting only so much of the teeth as stand above the gums, and the peculiar places on the bones in which the muscles are inserted.

PERIPATETIC *philosophy*, that system taught and established by Aristotle, and maintained by his followers, the Peripatetics, called also Aristotelians.

The philosophy of Aristotle may be divided into three distinct branches; instrumental, theoretical, and practical. Under the first head are included his doctrines concerning logic; under the second, his principles of physics, pneumatology, ontology, and mathematics; and under the third, his system of ethics and policy. Upon all these we cannot enlarge; but shall refer to his doctrine concerning the human mind and animal life.

Aristotle, having undertaken to teach a new system of philosophy, was desirous of receding as far as possible from former philosophers, and particularly from Plato; and in treating upon any subject on which he had no new doctrine to offer, he gave old

opinions the air of novelty, by clothing them in new language. This latter method he adopted on the subject of mind. He asserted with Plato, that there are in men different faculties, which have respectively a different organ; but he designedly expressed his doctrine upon this head in obscure terms, which cannot be explained with entire perspicuity without supposing, as many writers have done, what Aristotle ought to have taught, instead of endeavouring to discover what he actually did teach. His leading tenets on this subject are these:—The soul is the first principle of action in an organised body, possessing life potentially. The soul does not move itself; for whatever moves is moved by some other moving power. It is not a rare body, composed of elements; for then it would not have perception more than the elements which compose it. The soul has three faculties, the nutritive, the sensitive, and the rational; the superior comprehending the inferior potentially. The nutritive faculty is that by which life is produced and preserved. The sensitive faculty is that by which we perceive and feel; it does not perceive itself nor its organs, but some external objects through the intervention of its organs, which are adapted to produce the sensations of sight, hearing, smell, taste, and touch. The senses receive sensible species, or forms, without matter, as wax receives the impression of a seal, without receiving any part of its substance. The external senses perceive objects; but it is the common, or internal sense, which observes their difference. The internal sense perceives various objects at the same instant. Perception differs from intellect; the former being common to all animals, the latter to a few. Fancy is the perception produced in any animal by the immediate action of the senses. It is accompanied with different feelings, according to the nature of the object by which it is produced. Memory is derived from fancy, and has its seat in the same power of the soul. It is the effect of some image impressed upon the soul by means of the senses. Where this image cannot be retained, through an excess of moisture or dryness in the temperature of the brain, memory ceases. Reminiscence is that faculty of the mind by which we search for any thing which we wish to recollect through a series of things nearly related to it, till at last we call to mind what we had forgotten. The intellect is that part of the soul by which it understands. It is of two kinds, passive and active. Passive intellect is that faculty by which the understanding receives the forms of things: it is the seat of species. Active intellect is the efficient cause of all knowledge; and is either simple, when it is employed in the near apprehension of its object; or complex, when it compounds simple conceptions, in order to produce belief and assent. The latter is either true or false, the former neither. The action of the intellect is either theoretical or practical; theoretical, when it simply considers what is true or false; and practical, when it judges whether any thing is good or evil, and hereby excites the will to pursue or avoid it. The principle of local motion is the desire, or aversion, which arises from the practical exercise of the understanding. This desire, or aversion, produces either rational volition or sensitive appetite. The production of animal life arises from the union of the nutritive soul with animal heat. Life is the continuance of this union; death, its dissolution.

The nature of the first principle of animal life, and of all perception, intelligence, and action, Aristotle, as well as all other philosophers, was at a loss to explain. Having no other way of judging concerning it than by observing its operations as far as they are subjects of experience, he could only define the mind to be that principle by which we live, perceive, and understand. When he attempted to form an abstract conception of this principle, he saw that there must be some substance which enjoys such perfection as to be capable of performing this function; but he was wholly ignorant of the nature of this substance, and therefore in defining it he made use of a term expressive of the confused idea which he had formed to himself from observing its operations, and called it perfect energy; that is, if he had confessed the truth, some substance which is adapted to produce sensitive and rational life in certain organized bodies.

This term will afford the attentive reader a striking example of the manner in which Aristotle endeavoured to explain the principles of nature by vague notions and unmeaning words. But on other subjects he is sometimes remarkably clear, as in his discussion on "Politics" he states, in few words, the only legitimate purpose of political establishments. "Every political society forms, it is plain, a sort of community or partnership, instituted for the benefit of

the partners. Utility is the end and aim of every such institution; and the greatest and most extensive utility is the aim of that great association comprehending all the rest, and known by the name of the commonwealth." Having stated and explained the grand purposes of society, he considers the best systems of means for attaining those purposes, and traces the distinction of ranks which arises from the inequalities of individual talents, virtue, and fortune. Political institutions are best fitted for promoting human happiness, when they are most suitable to the opinions and sentiments of the people, and the circumstances of the times and country. No one political system will equally suit all situations, and scarcely any two. Government being an arrangement, the best government must be the best arrangement, and the best arrangement is that in which the materials to be arranged are the best fitted both to receive and to preserve. The materials of the statesman or legislator are the number and character of his people, and the extent and quality of his country. The excellence of a commonwealth, however, is not to be estimated by its populousness or extent, but by its fitness for performing its proper functions; the same energies and habits constitute the happiness both of individuals and of nations. Men make governments, not governments them; nor by any system of political arrangements can a happy commonwealth be constituted from fools or cowards, profligates or knaves. The bricks must be first prepared before the edifice can be reared. The human character is a compound of good and evil; the former arises from the balance of the affections, under the controul and guidance of reason, the latter results from passion operating without restraint. That government is the best which most powerfully stimulates the energies of the people to beneficial purposes, and restrains them from hurtful pursuits. That must be a system of freedom, in the first place tempered by order, and moderation in the second. Mixed governments, wisely formed and balanced, best correspond to the state of mankind. Democracy, though apparently most agreeable to the rights of man, is not the best adapted to his wants; the general will, unrestrained, is apt to run into excess; to be precipitate in deliberation, and tardy in execution. While simple democracy is inexpedient for the people themselves, simple aristocracy and simple monarchy are equally inexpedient; and being the subjection of the many to a few, or to one, are moreover unjust. For these reasons Aristotle recommends a constitution that combines and balances the three orders as the most generally likely to promote the good of society.

To his "Treatise on Politics" Aristotle has added two books on "Oeconomics," in which he has treated in a similar way on the management of domestic concerns.

Nothing is to be met with in the writings of Aristotle which decisively determines whether he thought the soul of man mortal or immortal; but the former appears most probable, from his notion of the nature and origin of the human soul, which he conceived to be an intellectual power, externally transmitted into the human body from an Eternal Intelligence, the common source of rationality to human beings. Aristotle does not inform his readers what he conceived this universal principle to be; but there is no proof that he supposed the union of this principle with any individual to continue after death.

PERIPHERY, in geometry, the circumference of a circle, ellipses, or any other regular curvilinear figure.

PERIPLOCA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: nectary encircling the gentials, and putting forth five threads. There are thirteen species, of which P. græca, common Virginian silk, or periploca, has shrubby, twining stems, covered with a dark-coloured bark, sending out slender branches, twining round each other; leaves ovate, lanceolate, nearly four inches long, and two broad in the middle; of a lucid green on their upper side, paler underneath, opposite, on short foot-stalks; the flowers appear near the ends of the small branches in bunches of a purple colour, in the months of July and August.

PERISCII, in geography, the inhabitants of either frigid zone, between the polar circles and the poles; where the sun, when in the summer signs, moves only round about them, without setting, and consequently their shadows, in the same day, turn to all the points of the horizon.

PERISTALTIC, in medicine, a vermicular spontaneous motion of the intestines, performed by the contraction of the circular and longitudinal fibres, of which the fleshy coats of the intestines is composed; by means whereof the chyle is driven into

the orifices of the lacteal veins, and the fæces are protruded towards the anus.

PERITROCHIUM, in mechanics, denotes a wheel, or circle, concentric with the base of a cylinder, and moveable together with it, about an axis. See MECHANICS.

PERIWINKLE. See BUCCINUM.

PERMIT, a licence or warrant for persons to pass with or sell goods, having paid the duties of customs and excise.

PERMUTATION *of quantities*, in algebra, the same with combination. See COMBINATION.

PERORATION, in rhetoric, the epilogue, or last part of an oration, wherein what the orator had insisted on through his whole discourse, is urged afresh with greater vehemence and passion. The peroration consists of two parts: 1. Recapitulation, wherein the substance of what was diffused throughout the whole speech is collected briefly, and cursorily, and summed up with new force and weight. 2. The moving the passions, which is so peculiar to the peroration, that the masters of the art call this part sedes affectuum. The passions to be raised are various, according to the various kinds of oration. In a panegyric, love, admiration, emulation, joy, &c. In an invective, hatred, contempt, &c. In a deliberation, hope, confidence, or fear. The qualities required in the peroration are, that it be very vehement and passionate, and that it be short; because, as Cicero observes, tears soon dry up.

PEROTIS, in botany, a genus of the Triandria Digynia class and order. Essential character: calyx none; corolla two-valved; valves equal, awned. There are two species, viz. P. latifolia, and P. polystachya, both natives of the East Indies.

PERPENDICULAR, in geometry, a line falling directly on another line, so as to make equal angles on each side; called also a normal line. See GEOMETRY.

PERPENDICULAR *to a parabola*, is a right line cutting the parabola in the point in which any other right line touches it, and is also itself perpendicular to that tangent.

PERPETUAL *screw*, is one which is acted upon by the teeth of a wheel, and which continues its action for an indefinite length of time, or as long as the teeth of the wheel continue to act upon it.

PERPETUITY, in the doctrine of annuities, is the number of years in which the simple interest of any principal sum will amount to the same as the principal itself; or it is the number of years' purchase to be given for an annuity which is to continue for ever; and it is found by dividing 100*l.* by the rate of interest agreed upon: thus allowing 5 per cent, the perpetuity is £ $\frac{100}{5} = 20$; and at the rates usually adopted, the perpetuity is as follows:

At 3 per cent. $\frac{100}{3} = 33.333$, &c.

$3\frac{1}{2}$............ $\frac{100}{3.5} = 28.57$, &c.

4............ $\frac{100}{4} = 25$.

$4\frac{1}{2}$............ $\frac{100}{4.5} = 22.22$, &c.

5............ $\frac{100}{5} = 20$.

6............ $\frac{100}{6} = 16.66$, &c.

7............ $\frac{100}{7} = 14.28$, &c.

8............ $\frac{100}{.8} = 12.5$.

These are the number of years purchase to be given for a perpetual annuity, on the supposition that it is receivable yearly.

PERPETUITY, in law, is where, if all that have interest join in the conveyance, yet they cannot bar or pass the estate; for, if by concurrence of all having interest, the estate may be barred, it is no perpetuity.

PERRY, a drink made of pears, in the same manner as cyder is made from apples. See CYDER. The pears must be perfectly ripe, and to give the liquor a greater degree of tartness, some mix crabs with them. The best fruit for making perry is such as is least fit for eating, as the choak-pear, boreland-pear, horse-pear, and the barberry-pear.

PERSEUS, in astronomy, a constellation of the northern hemisphere, which, according to the catalogues of Ptolemy and Tycho, contains twenty-nine stars; but in the Britannic catalogue, sixty-seven.

PERSIAN *wheel*, an engine, or wheel, turned by a rivulet, or other stream of water, and fitted with open boxes at its cogs, to raise water for the overflowing of lands, or other purposes. It may be made of any size, according to the height the water is to be raised to, and the strength of the stream by which it is turned. This wheel is placed so, that its bottom only is immersed in the stream, wherein the open boxes at its cogs are all filled one after another with water, which is raised with them to the upper part of the wheel's circuit, and then naturally

empties itself into a trough, which carries it to the land.

PERSON, in dramatic poetry, the character assumed by an actor, or he who is represented by the player. Thus, at the head of dramatic pieces, is placed the dramatis personæ, or list of the persons that are to appear on the stage. Father Bossu observes, that in the epic and dramatic poem, the same person must reign throughout; that is, must sustain the chief part through the whole piece, and the characters of all the other persons must be subordinate to him.

PERSON, in grammar, a term applied to such nouns or pronouns, as being either prefixed or understood, are the nominatives in all inflexions of a verb; or it is the agent or patient in all finite and personal verbs. See GRAMMAR.

PERSONAL *tithes*, tithes paid of such profits as come by the labour of a man's person, as by buying and selling, gains of merchandise, and handicrafts, &c.

PERSONALITY, an action is in the personality, where it is brought against the right person, or the person against whom in law it lies.

PERSONATE, in law, is the representing a person by a fictitious or assumed character, so as to pass for the person represented. Personating bail, is by stat. 21 Jac. I, c. 26, a capital felony. By various other statutes, personating seamen entitled to wages, prize-money, &c. is also a capital felony.

PERSONATÆ, in botany, *masked*, the name of the fortieth order in Linnæus's Fragments of a Natural Method, consisting of a number of plants whose flowers are furnished with an irregular gaping petal, which, in figure somewhat resembles the snout of an animal. Most of the genera of this natural order arrange themselves under the class and order "Didynamia Angiospermia." The rest, although they cannot enter into the artificial class just mentioned, for want of the classic character, (the inequality of the stamina), yet, in a natural method, which admits of greater latitude, may be arranged with the Personatæ, which they resemble in their habit and general appearance, and particularly in the circumstance expressed in the title. This order furnishes both herbaceous and woody vegetables of the shrub and tree kind. The roots are generally fibrous and branched; in gerardia and tozzia, they are tuberous. The roots of broom-rape are parasitical; that is, attach themselves to the roots of other plants, from which they derive their nourishment. The stems and branches are cylindrical when young, except in some species of fig-wort, in which they are square. The leaves are simple, generally placed opposite in pairs at the bottom of the branches, but in many genera, stand alternate towards the top. Some species of trumpet-flower have the common foot-stalk of their winged leaves terminated by a tendril, with three or five branches. In a species of cornutia is observed a stipula or scale, in form of a half-moon, of the same substance with the leaves between which it is placed. The flowers are universally hermaphrodite. They proceed either singly, or in clusters, from the wings of the leaves, as in American viburnum, or terminate the branches in a spike, panicle, or head, as in cornutia, vervain, &c. In the latter they seem placed in whorls. The calyx, or flower-cup, is of one leaf, which is cut into two, three, four, or five divisions that are permanent. In the trumpet-flower, the calyx falls off early, and generally resolves itself into five distinct leaves. The corolla is composed of one irregular petal, with two lips, resembling the head or snout of an animal. In toad-flax, the petal is terminated behind by a nectarium in form of a spur. The stamina in plants of the first section, are two or four in number. In hedge-hyssop, and some species of vervain, the filaments are four in number, but two of these only are terminated by anthers; so that the number of perfect stamina in these plants is only two. The seed-bud is single, and placed above the receptacle of the flower. The style is single, thread-shaped, bent in the direction of the stamina, and crowned with a stigma, which is generally blunt, and sometimes divided into two. The seed-vessel is a capsule, generally divided internally into two cavities, and externally into the same number of valves. The seeds are numerous, and affixed to a receptacle in the middle of the capsule.

PERSOONIA, in botany, so named in honour of C. H. Persoon; a genus of the Tetrandria Monogynia class and order. Essential character: calyx none; petals four, staminiferous towards the base; glands four at the base of the germ; stigma blunt; drupe one-seeded. This genus consists of subvimineous shrubs; leaves commonly alternate, without stipules; corolla smooth within; anthers linear, finally bent back; style permanent, smooth; drupe eatable in

most; flowers yellow. Natives of the islands in the Southern Ocean.

PERSPECTIVE is the foundation of all the polite or liberal arts that have their basis in drawing; though colouring, taken abstractedly, does not come within its rules, yet the painter as well as the sculptor and architect cannot but derive essential advantages from a knowledge of perspective; it is indeed difficult to conceive how a person who has not either been instructed in, or been gifted by nature with some idea of the effects produced by locality and distance, can form any thing like a correct opinion of the merits of those imitations of nature which come under the heads of portrait, landscape, figure, or architectural drawing.

Perspective is, in brief, the art of representing, upon a plane surface, the appearance of objects, however diversified, similar to that they assume upon a glass-plane interposed between them, and the eye at a given distance. The representation of a solid object on a plane surface can shew the original in no other point of view but that from which it is at the time beheld by the draughtsman; the least change in any of the parts requires a change in the whole; unless in fancy drawings where a fac-simile is not required. Nor can any deviation from the several lines, which will be hereafter explained, and on which the truth and correctness of representation depend, be allowed without changing the bearings, directions, and tendency of all the perspective lines which constitute the basis of that faithful and converging series which unite all the component parts in the most pleasing and harmonious concinnity.

By perspective we are taught to delineate objects on a plane, upon geometrical principles, and in exact ratio with their several magnitudes, governed by their distance. But it is not in the power of art to represent any single figure, (exact as it appears in nature), on a plane, except it be a circle; and then the point of sight, or direct position of the eye, must be perfectly centrical. The reasons for this are obvious; every object which recedes from the eye, (such as a row of houses in an oblique direction), inevitably requires that its more remote parts should be represented as being of less magnitude than those more in front, that is, nearer to the spectator. Now, although it is considered an axiom in perspective that all objects standing parallel to the base line, or bottom of the picture, should be represented as preserving in every instance the real proportions of the scale from which their parts were taken; yet when we analyze the object, according to the various angles those several parts make with the eye, we shall find that even such full pointing figures require their more remote parts to be reduced in proportion as they become more distant from the centre, or point of sight. But it will be obvious, that where the object is very remote, there must be the less necessity for such scrupulous attention; therefore when we draw an extensive mansion, full fronting, at a great distance, we describe all the horizontal lines in the building, by horizontal lines in the drawing; so long as they come under an angle of 60 degrees; which is the natural range of sight, and beyond which no picture should ever extend; when beyond that angle, we cannot take the whole picture at one view; but must treat it as a panorama, and view the several parts abstractedly. When a building is so near as to occasion turning our heads round for the purpose of seeing its several parts, they have the same effect, and compel us to have recourse to various vanishing points in which we seek the termination of those lines that converge, and in fact divide the building, though full fronted and uniform, into several parts; each of which seems to assume a distinct character, and to demand separate consideration. This will be more fully understood when we treat of the general rules which govern perspective. The reader must recollect, that, as it would be impossible to represent more than one view of the object, in one plane, or picture, so there can be but one point of sight; that is, but one particular spot, where the eye of the spectator is supposed to be fixed; from which, as from a very minute point, all the figures represented must appear as under one general system. The same attention must of course be paid to shadows; for we cannot suppose the dark side of a house to result from any thing but the light being in such a quarter as does not allow it to strike on that side; consequently we attribute the bright side of the same object to its being illuminated by the rays which act peremptorily upon it. Speaking of common effects, we consider the light to be solitary; such as the Sun, or the Moon, or one candle, &c.; hence we perceive both the necessity, and the reason, for exhibiting all objects as bright, which are within the range of, or shew themselves openly to, the light, and all parts to which its rays cannot reach direct,

as being in the shade, and more or less dark according as they may be more retired and confined. When two lights are found in the same picture, such as two candles on a table, there will be to every object under their mutual influence a half shade, and a whole shade; the former called the penumbra, shewing that extent which results from one light being obscured, or cut off; and the latter or the umbra, shewing those parts which are not acted upon by either of the lights. This will be obvious to any person who may place two candles behind him, as he sits with his back to a table; they being about two feet asunder. He will then see, on the wall, the influence of each candle; and his shadow will increase with the remoteness of the plane, or wall, on which it is represented.

The following definitions of the principle features in the science and application of perspective will prove useful to the student, *viz.* projection delineates objects in plano, by means of right lines called rays, supposed to be drawn from every angle of the object, to particular points. When the objects are angular, these rays necessarily form pyramids, having the plane or superfices, whence they proceed for their basis; but when drawn from, or to, circular objects, they form a cone.

Ichnography, or ichnographic projection, is described by right lines parallel among themselves, and perpendicular to the horizon, from every angle of every object, on a plane parallel to the horizon. The points where the perpendicular lines or rays cut that plane being joined by right lines. The figure projected on the horizontal plane is likewise called the plan, or seat of that object on the ground plane. The points are the scites, or seats, of the angles of the object. The lines are the seats of the sides. By this we are to understand how the basis of figures represented as superstructures stand, or are supported; and we are further enabled to judge of, indeed to measure, their several parts, and their areas.

Orthography represents the vertical position and appearance of an object; hence orthographic projection is called the elevation. When we thus see the front of a house, we give it that term; but when the side is displayed, we call it the profile. If we suppose a house, or other object to be divided by a plane passing perpendicularly through it in a line at right angles with the point, we call it the lateral section; but if the plane pass in a direction parallel with the front, it is termed a longitudinal section. If the plane passes in neither of the former directions (not however deviating from the vertical) it is said to be an oblique section.

These give us the modes of laying down plans, of shewing the parts, and the manner in which the interiors of edifices are arranged; consequently are indispensable to the architect, surveyor, and indeed should be understood by every person in any way connected with building, or designing. Nor should the following be neglected, *viz.* scenography, which shews us how to direct the visual rays to every point, or part, of a picture; and stereography, which enables us to represent solids on a plane, from geometrical projection; whence their several dimensions, *viz.* length, breadth, and thickness may all be represented, and be correctly understood at sight. We suppose our readers to have some knowledge of geometry before they commence upon this, or any other of the abstract sciences which are founded thereon. Should such, however, not be the case, we beg leave to refer them to that head, where they will find sufficient instruction to enable them to prosecute their enquiries on the subject now before us.

An original object, is that which becomes the subject of the picture, and which is the parent of the design. Any plane figure may become an object, as may any of its parts, as a broken pillar, the ruins of a house, the stump or the branch of a tree; but we generally speak of objects as relating to entire figures represented as solids, or to as much rural or other scenery as may be embraced under an angle of 60 degrees formed by two lines meeting at the eye. This will explain why we are enabled to represent so great a number of distant objects, while the front, or fore-ground, will contain, comparatively, but a very few: it being obvious that as the lines forming the angle become more distant, the more may be included between them.

Original planes, or lines, are the surfaces of the objects to be drawn; or they are any lines of those surfaces; or it means the surfaces on which these objects stand.

Perspective plane is the picture itself, which is supposed to be a transparent plane, through which we view the objects represented thereon.

Vanishing planes are those points which are marked upon the picture, by supposing lines to be drawn from the spectator's eye

parallel to any original lines, and produced until they touch the picture.

Ground plane is the surface of the earth, or plane of the horizon, on which the picture is supposed to stand.

The ground line is that formed by the intersection of the picture in the ground plane.

The horizontal line is the vanishing point of the horizontal plane, and is produced in the same manner as any other vanishing line, viz. by passing a plane through the eye parallel to the horizontal plane.

The point of sight is the fixed point from which the spectator views the perspective plane.

Vanishing points are the points which are marked down in the picture, by supposing lines to be drawn from the spectator's eye, parallel to any original lines, and produced until they touch the picture.

The centre of a picture is that point on the perspective plane where a line, drawn from the eye perpendicular to the picture, would cut it; consequently it is that part of the picture which is nearest to the eye of the spectator.

The distance of the picture is the distance from the eye to the centre of the picture. If what has been already said and repeated, regarding the angle of 60 degrees, is understood, the spectator will never bring the picture so near to himself as to occasion the eyes to expand, indeed to strain, so as to embrace more than that angle.

The distance of a vanishing point is the distance from the eye of the spectator to that point where the converging lines meet, and after gradually diminishing all the objects which come within their direction and proportion, are reduced so as in fact to terminate in nothing. All parallel lines have the same vanishing point; that is to say, all such as are in a building, parallel to each other, when not represented exactly opposite to, and parallel with the eye, will appear to converge towards some remote point, *i. e.* their vanishing point. Circles, when retiring in such manner, are represented by ellipses, proportioned to their distances: their dimensions in perspective are ascertained by enclosing them, or the nearest of them, where a regular succession is to be pourtrayed within a square, which being divided into any number of equal parts or chequers, will show all the proportions of those more remote. We trust it scarcely requires to be repeated that the further any object is from the eye or fore-ground of a picture, the less it will appear in nature, and the more it must be reduced in exhibiting its perspective.

A bird's-eye view is supposed to be taken from some elevated spot which commands such a prospect as nearly resembles the plane or ichnography of the places seen. Thus the view from a high tower, or from a mountain, whence the altitudes of the several objects on the plane below appear much diminished, gives nearly the same representation as is offered to a bird flying over them; whence the term. Some idea may be formed of this by standing on any height, and observing how low those objects, which are near thereto, will appear when compared with those more distant, taking, however, the perspective diminution of the latter into consideration.

We shall now explain the five figures included in the Plate of Perspective. The first figure shews a base line, A B, divided into eight equal parts, whose perspective proportions on the lines A C and B C, are shewn by drawing, from the several divisions, 1, 2, 3, 4, &c. on A B, rays to the vanishing points, D and E, situated on the horizon. If A C and B C were of equal length, the several squares thus made in the area, A C B, would shew trapezia regularly diminishing towards C, having their opposite angles intersectable by perpendiculars from the base line, A B, and the other opposite angles intersectable by horizontal lines parallel to A B. But A C being longer than B C, gives the whole of the trapezia a cast towards E. This shews that the two vanishing points, while, (in this instance) they serve to intersect each other, contain distances, considered perspectively, in proportion to their brevity; they are under the same parallels, but the angle, B A C, being smaller than the angle, C B A, causes the divisions on A C to be more extensive than those on B C, as may be seen by referring to the lesser spaces occupied by the standard on the latter. The figures 1, 2, 3, &c. correspond with those on the base line, exhibiting their due perspective distances on the lines A C and B C. It will also be observed, that as the trapezia become more distant, they become smaller, while their angles pointing towards C, and towards the base line, that is, their perpendicular angles become more obtuse, and their horizontal angles, *i. e.* those on the right and left, become more acute: were it otherwise, they could not produce a

diminution of the trapezia in proportion to distance.

Fig. 2, shews the angle formed by two ranges of buildings, each of which has a different vanishing point. N O is the perpendicular edge of the angle; N Q O, and N P O, shew the two faces, each of which is intersected by streets of various breadths. In both instances the spectator's eye is supposed to be situated near two-thirds up the two buildings; that is to say, about X on one face, and about W on the other. This produces a mixed effect, seldom to be found in reality; though in some cases, where streets lying on a declivity, and joining others with less deviation from the level, this will be produced. The mode of proving the due direction of lines in perspective, such as X Q, and W P, which appear like the bands or fillets that separate the different stories of an edifice, is very simple; namely, all horizontal lines in buildings that decline from the plane of a picture, and tend towards some vanishing point, will, when above the spectator's eye, appear to descend towards that point, as from N to Q; but when below the spectator's eye, they will appear to rise as O Q. The triangle O Q N being more acute will give a more direct view of the houses, and appear to recede less from the eye than N P Q, which is more obtuse, and makes every house appear narrower.

Fig. 3, shews the front of a house, I H F G, which, when thrown into perspective by the vanishing point, Q, being made high, and several rays proceeding from *o p q r s t* to *k* being carried too high, give an *outré* appearance to the front as shewn by the outlines I F L M, in which it will be seen that a rude and unpleasant disproportion is given in every part. Nor is this even the manner in which the house would appear when seen from above, or below it; on the principle of a bird's eye view. The places of the several doors and windows being ascertained, the several lines, *o p q r s t*, intersect the ground-line F M in those parts which correspond with the places of the doors; whose heights are ascertained or determined by the line S Q, equal at S F to their height in the original front I H F G.

The windows being over the doors, must be under the same perpendiculars in both cases; their depth is determined by taking the measurements on the line I S, and drawing rays to the point Q. This figure is given chiefly with the intention of shewing the immense disproportions which are generated by a false placing of the point to which the rays proceed; and which point is always formed to advantage rather below than above the centre of a picture. When the horizon is too much raised, numberless distortions take place.

Fig. 4, gives the ground plan of a gallery, R S V T, which is to be shewn in perspective with its several standards, and the pitch of the awning on the ground lines V X and W X. Here Π Φ becomes the horizontal line, on which X is the vanishing point, and Φ the point to which the rays R Φ, 9 Φ, 10 Φ, and W Φ being drawn, cut V X in the places marked 4, 3, 2, 1, respectively, and give the situations of the standards for the right side. The places for those on the left side are found by drawing the lines 5, 4; 6, 3; 7, 2; 8, 1; all parallel to W V. In this instance all the intervals, R, 9; 9, 10; 10, W; and W, V; being equal, the proximate superior ray will always give that parallel: thus the ray of R Φ cuts X W exactly at the point 6, which gives the line 6, 3, parallel to 7, 2; and so of all in succession. The lines Y Z and W V are parallel; they determine the height of the front standards, and by means of the lines Y X and Z X cut the other standards at their proper heights. Their descent towards X shew them to be above the line Π Φ, which is level with the spectator's eye. The summits of the couples are ascertained by the line Δ X. They will all have their centres over the centres of the lines 5, 4; 6, 3; 7, 2; and 8, 1; ascertained by drawing a line from B to X.

Fig. 5, exhibits the wall of a monastery, supported in some parts by reinforcements, or pillars, between which the wall is less substantial. The measurement of the pillars and of the intervals is given on the base-line A B, while G F shews the horizon and line of sight. The rays from *a*, *c*, *e*, and *g*, shew the places where the several divisions take place on the ground-line A E, and shew the projections of *b*, *d*, *f*, *h*. The upper line is also determined by C D, and the crosses in like manner are made to diminish towards the vanishing point F. The small mark at A in the middle of the wall's thickness, as shewn by the shaded part, gives rule for each projection of the several pillars, as shewn by the shaded parts: their summits and bases will, however, have their fronts, *i. e.* the parts parallel with C A, terminated by horizontal lines parallel with A B. We must once more impress, that all fronting horizontals in nature must be

so represented in perspective, provided they do not extend beyond 60°; also, that in every instance perpendiculars in nature are so delineated in perspective.

The reader will have seen, that the base-line, and the depth below it, give the measure of the figure when obliqued. To render this more perfectly intelligible, let us say that it were necessary to place the square W, V, 13, T in perspective between W, V and X (fig. 4). This being a square is readily done; the more so, as it is proximate to the line; because the quadrant T W is so readily acted upon; W V being equal to V T. But say that it were needful to place the line T K (fig. 4) in perspective on the line V X. Draw the quadrant T, W; and the quadrant K, 10; the line W, 1, drawn to ⊕, will shew the place of T, and the line 8, 2, will shew the place of K: therefore the line T K will be found in perspective between the points 1 and 2 on the line V X. Thus any line or object may be represented; observing that the distance at which it stands below the base-line must be measured on the base-line; when, by drawing rays to the horizontal line, (whereon all the vanishing points must rest) its place on the oblique line, or scite, will be determined. Some authors on this subject have directed that the back ground should be limited by a semicircle, describing the half-horizon, and that all the vanishing points ought to be placed thereon. This, however well it may answer in a panoramic point of view, can never be so appropriate, as the horizontal line, in a picture which includes only the sixth part of a circle.

What has been said relates entirely to mathematical perspective, and forms the basis of architectural design, and governs (though rather occultly) every kind of landscape painting: with regard to the perspective of living objects, and of varied nature, that can only be acquired by attention to models, and to the real figures.

Perspective, *aerial*, is the art of giving a due diminution or degradation to the strength of the light, shade, and colours of objects, according to their different distances, the quantity of light which falls on them, and the medium through which they are seen.

As the eye does not judge of the distance of objects entirely by their apparent size, but also by their strength of colours, and distinction of parts; so it is not sufficient to give an object its due apparent bulk according to the rules of stereography, unless at the same time it be expressed with that proper faintness and degradation of colour which the distance requires. Thus if the figure of a man, at a distance, were painted of a proper magnitude for the place, but with too great a distinction of parts, or too strong colours, it would appear to stand forward, and seem proportionally less, so as to represent a dwarf situated nearer the eye, and out of the plane on which the painter intended it should stand.

By the original colour of an object is meant that colour which it exhibits to the eye when duly exposed to it in a full open uniform light, at such a moderate distance as to be clearly and distinctly seen. This colour receives an alteration from many causes, the principal of which are the following.

1. From the objects being removed to a greater distance from the eye, whereby the rays of light which it reflects are less vivid, and the colour becomes more diluted and tinged, in some measure, by the faint bluish cast, or with the dimness or haziness of the body of air through which the rays pass.

2. From the greater or less degree of light with which the object is enlightened; the same original colour having a different appearance in the shades, from what it has in the light, although at an equal distance from the eye, and so in proportion to the strength of the light or shade.

3. From the colour of the light itself which falls upon it, whether it be from the reflection of coloured light from any adjacent object, or by its passage through a coloured medium, which will exhibit a colour compounded of the original colour of the object, and the other accidental colours which the light brings with it.

4. From the position of the surface of the object, or of its several parts with respect to the eye; such parts of it appearing more lively and distinct than those which are seen obliquely.

5. From the closeness or openness of the place where the object is situated; the light being much more variously directed and reflected within a room, than in the open air.

6. Some original colours naturally reflect light in a greater proportion than others, though equally exposed to the same degrees of it; whereby their degradation at several distances will be different from that of other colours which reflect less light.

From these several causes it happens that

the colours of objects are seldom seen pure and unmixed, but generally arrive at the eye broken and softened by each other; and, therefore, in painting, where the natural appearances of objects are to be described, all hard or sharp colouring should be carefully avoided.

A painter, therefore, who would succeed in aerial perspective, ought carefully to study the effects which distance, or the different degrees or colours of light, have on each particular original colour, to know how its appearance or strength is changed in the several circumstances above mentioned, and represent it accordingly; so that, in a picture of various coloured objects, he may be able to give each original colour its own proper diminution or degradation according to its place.

Now, as all objects in a picture are proportioned to those placed in the front; so in aerial perspective the strength of light, and the brightness of the colours of objects close to the picture, must serve as a standard; with respect to which, all the same colours, at different distances, must have a proportional degradation in like circumstances.

In order, therefore, to give any colour its proper diminution in proportion to its distance, it ought to be known what the appearance of that colour would be, were it close to the picture, regard being had to that degree of light which is chosen as the principal light of the picture. For if any colour should be made too bright for another, or for the general colours employed in the rest of the picture, it will appear too glaring, seem to start out of its place, and throw a flatness and damp upon the rest of the work; or, as the painters express it, the brightness of that colour will kill the rest.

Perspective *glass*, in optics, differs from a telescope in this: instead of the convex eye-glass placed behind the image, to make the rays of each pencil go parallel to the eye, there is placed a concave eye-glass as much before it; which opens the converging rays, and makes them emerge parallel to the eye. The quantity of objects taken in at one view with this instrument does not depend upon the breadth of the eye-glass, as in the astronomical telescope, but upon the breadth of the pupil of the eye.

Reflecting perspective glasses, called by some opera-glasses, or diagonal perspectives, are so contrived that a person can view any one in a public place, as the opera or play-houses, without it being possible to distinguish who it is he looks at. See Opera *glass*.

Perspective *plane*, is the glass, or other transparent surface, supposed to be placed between the eye and the object, perpendicular to the horizon. It is sometimes called the section, table, or glass.

PERSPIRATION, in medicine, the evacuation of the juices of the body through the pores of the skin. Perspiration is distinguished into sensible and insensible. See Physiology.

The skin of man and of animals is pierced with an infinitude of pores, through which, by means of the transpiration, the parts of the aliments escape which do not contribute to nourishment. Independently of the sensible perspiration, which is called sweat, and which is accidental, there is, moreover, one that is insensible, acting more or less at every instant, and which none could conceive to be so abundant as it is, before the experiments of Sanctorius. This celebrated philosopher had the resolution to pass a part of his life in a balance, wherein he weighed himself, in order to determine the loss occasioned by the effects of the insensible perspiration. He has found that this kind of evacuation causes us to lose, in the space of twenty-four hours, about five-eighths of the nutriment which we have taken. Dodard, in repeating afterwards the same experiments, has had regard to the difference of age, and is convinced that a person perspires much the most in his youth. But the philosophers who have directed their attention to this object, have not sufficiently distinguished the effect of the perspiration or transpiration which is performed by the lungs, and of which the matter escapes by expiration, from the effect which is attributable to the cutaneous perspiration, or to that which obtains through the intermediation of the skin. Seguin has undertaken, in conjunction with Lavoisier, to determine these two effects separately; and after having sought, in the usual manner, the total result of the transpiration, has suppressed that which is performed by the skin, by applying upon that organ a cover impermeable to the humour which it transmits outwardly: thus has been obtained the quantity of the pulmonary transpiration: and the mean between the results of these experiments gives seven-elevenths for the ratio between this quantity and that of the cutaneous per-

spiration; that is, the effect produced by the pulmonary transpiration is more than the third of the total effect.

PERUKE. It appears that this term was originally applied to describe a fine natural head of long hair; but whatever may have been the ancient use or meaning of the word, it has now almost become obsolete, though it was for more than a century in constant application to those artificial heads of hair, made probably at first to conceal natural or accidental baldness, but which afterwards became so ridiculously fashionable, as to be worn in preference to the most beautiful locks, absurdly shaved off the head to make room for them.

Ancient authors might be quoted to prove that the great and luxurious of that time had recourse to this mode of concealing defects, and of decorating the head; nay, it might perhaps be proved, that the peruke of the Emperor Commodus was more absurdly composed than any modern peruke has ever been; and indeed it must be admitted, that a wig powdered with scrapings of gold, in addition to oils and glutinous perfumes, must have made a more wonderful appearance than our immediate ancestors ever witnessed. It was in the reign of our Charles the First that perukes were introduced throughout Europe, when the moralists attacked them without mercy, as they perceived that the folly of youth even extended to the cutting off nature's locks, to be replaced by the hair of the dead, and of horses, woven into a filthy piece of canvas. Admonition and ridicule was, however, of little avail, and the clergy began to be affected by the general mania. Those on the Continent being almost universally Roman Catholics, were so completely subject to their superiors, that the peruke was soon routed from their body; but as the dignified clergy of England conceive that their consequence is increased by the enormous bushes of hair upon their heads, and the judges have adopted their sentiments in this particular, it is probable many years will elapse before the shape and absurdity of two particular species of perukes are forgotten.

About the close of the seventeenth century the peruke was made to represent the natural curl of the hair, but in such profusion, that ten heads would not have furnished an equal quantity, as it flowed down the back, and hung over the shoulders, half way down the arms. By 1721, it had become fashionable to tie one half of it on the left side into a club. Between 1730 and 1740, the bag-wig came into fashion, and the peruke was docked considerably, and sometimes plaited behind into a queue, though even till 1752 the long flowing locks maintained their influence. After 1770 those were rarely seen; and since that time persons wearing perukes have generally had substantial reasons for so doing from baldness and complaints in the head. At one time, indeed, when the stern virtues of Brutus were much in vogue; the young men of Europe wore perukes of black or dark hair, dressed from his statues. Many particulars on this subject have been preserved by Mr. Malcolm, in his "Anecdotes of the Manners and Customs of London," from which we learn, that a young countrywoman obtained *60l.* for her head of hair in the year 1700, when human hair sold at *3l.* per ounce; and in 1720, the grey locks of an aged woman sold for *50l.* after her decease, as did wigs at *40l.* each, of peculiar excellence.

A petition from the master peruke-makers of London and Westminster, presented to the King in 1763, points out the final decline of their use to have taken place at that time. In this they complain of the public wearing their own hair; and say, "That this mode, pernicious enough in itself to their trade, is rendered excessively more so by swarms of French hair-dressers already in those cities, and daily increasing."

PERULA, in botany, a genus of the Dioecia Polyandria class and order. Generic character: male, calyx; perianthum two-leaved, very small corolla; petal one, semi-globular, concave, hanging down; stamens, filaments very many; pistil, germs four, barren, very small: female on a distinct tree; calyx, perianthum as in the male, deciduous; corolla as in the male; pistil, germs four, fertile; pericarpium capsule, obovate, subtrigonal; seeds solitary, small. The number of species not known. P. arborea is a native of New Granada, about Mariquita, where it was found by Mutis.

PETALOMA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx goblet-shaped, five-toothed; petals five, inserted between the teeth of the calyx; stamina on the margin of the calyx; berry one-celled; seeds one or four. There are two species, viz. P. myrtilloides and P. mouriri.

PETESIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rubiaceæ. Jussieu. Es-

sential character: corolla one-petalled, funnel-form; stigma bifid; berry many-seeded. There are three species.

PETIOLUS. See PEDUNCULUS.

PETIT (PETER) a considerable mathematician and philosopher of France, was born at Montluçon in the diocese of Bourges in the year 1589, according to some, but in 1600 according to others. He first cultivated the mathematics and philosophy in the place of his nativity; but in 1633 he repaired to Paris, to which place his reputation had procured him an invitation. Here he became highly celebrated for his ingenious writings, and for his connections with Pascal, Des Cartes, Mersenne, and the other great men of that time. He was employed on several occasions by Cardinal Richelieu; he was commissioned by this minister to visit the seaports, with the title of the King's Engineer; and was also sent into Italy upon the King's business. He was at Tours in 1640, where he married; and was afterwards made Intendant of the Fortifications. Baillet, in his Life of Des Cartes, says that Petit had a great genius for mathematics; that he excelled particularly in astronomy; and had a singular passion for experimental philosophy. He was intimately connected with Pascal, with whom he made, at Rouen, the same experiments concerning the vacuum, which Torricelli had before made in Italy; and was assured of their truth by frequent repetitions. He died August the 20th, 1667, at Lagny, near Paris, whither he had retired for some time before his decease. He published several works upon physical and astronomical subjects, also on chronology and theology.

PETITIA, in botany, so named in memory of Francis Petit, a genus of the Tetrandria Monogynia class and order. Natural order of Vitices, Jussieu. Essential character: calyx four-toothed, inferior; corolla four-parted; drupe with a two-celled nut. There is but one species, *viz.* P. Domingensis, a native of the island of St. Domingo.

PETITION, no petition to the King, or to either house of parliament, for any alteration in church or state, shall be signed by above twenty persons, unless the matter thereof be approved by three Justices of the Peace, or the major part of the Grand Jury in the county; and in London, by the Lord Mayor, Aldermen, and Common Council: nor shall any petition be presented by more than ten persons at a time.

PETITION *in chancery*, a request in writing, directed to the Lord Chancellor, or Master of the Rolls, shewing some matter or cause whereupon the petitioner prays somewhat to be granted him.

PETIVERIA, in botany, *Guinea henweed*, a genus of the Hexandria Tetragynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx four-leaved; corolla none; seed one, with reflex awns at top. There are two species, *viz.* P. alliacea, common Guinea hen-weed; and P. octandra, dwarf Guinea hen-weed: both natives of the West Indies.

PETREA, in botany, so named in honour of Lord Petre, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-parted, very large, coloured; corolla wheel shaped; capsule two-celled, at the bottom of the calyx; seeds solitary. There is but one species, *viz.* P. volubilis, a native of South America and the West Indies.

PETRIFACTION. See ORYCTOLOGY.

PETROCARYA, in botany, a genus of the Heptandria Monogynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx turbinate, five-cleft, with two bractes at the base; corolla five-petalled, less than the calyx; filaments fourteen, seven of which are barren; drupe inclosing a two-celled nut, with a stony shell. There are two species, *viz.* P. montana, and P. campestris, both found in the woods of Guiana, where they grow to the height of forty and eighty feet.

PETROLEUM, in chemistry. The substances which mineralogists have distinguished by the names of asphaltum, maltha, petroleum, and naptha, are thought by Mr. Murray, and others, to be mere varieties of one species, and form a series which passes even into coal. Asphaltum forms the connection with pitch-coal. It is found in veins, and in small masses, and also sometimes on the surface of lakes. Maltha is softer, has a degree of tenacity, and a strong bituminous smell. Petroleum is semi-liquid, semi-transparent, of a reddish-brown colour, and fetid odour. Naptha is of a lighter colour, more or less transparent, perfectly thin and liquid, light, odoriferous, volatile, and inflammable. Naptha by inspissation becoming petroleum, and this passing into asphaltum. See ASPHALTUM, BITUMEN, &c.

In several parts of France petroleum is found floating on the water, and is known in commerce by the name of oil of Gabian. Wells are sometimes dug 100 feet deep, where the petroleum is found mixed with the soil, in such propertion that ten pounds may be extracted from a hundred weight.

PETROMYZON, the *lamprey*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: body shaped like an eel; mouth beneath, with numerous teeth, in circular rows; seven spiracles on each side the neck; no pectoral, or ventral fins. Shaw notices nine species, and Gmelin only four. P. marinus, or the great lamprey, is usually of a brown olive colour, tinged with yellowish-white. It is often three feet long; is an inhabitant of the seas, as its name indeed implies; but in the beginning of spring ascends rivers in which it resides for a few months, then returning to the ocean. It is viviparous, and supposed to subsist almost entirely on worms and fishes. Its heart is enclosed not in a soft, but in a cartilaginous pericardium, constituting thus a singular deviation from the general structure of animals. Its spine also possesses the peculiarity of being rather a soft cartilage than bone. These fishes fasten themselves with the jagged edges of the mouth to large stones, with the most extraordinary firmness, and may be lifted by the tail to a considerable height without being made to quit a stone of the weight of even ten or twelve pounds. Their principle of vitality is extremely vigorous and persevering, various parts of the body long continuing to move for some hours after it is divided; and the head will adhere to a rock for hours after the greater part of the body is cut away. In some large rivers of Europe these fishes are taken in vast numbers, and preserved with spices and salt as an article for merchandise. In this country the Severn is the most celebrated river for them, and they are much valued on their first arrival from the sea. They are considered a high luxury for the table, and the life of one of the Kings of England will be recollected to have been terminated by his excessive partiality to potted lampreys.

P. fluviatilis, or the lesser lamprey, is about twelve inches long, inhabits also the sea, but is found more frequently in the rivers than the former. It abounds in the Thames and Severn, and is preferred by many to the larger species, as being not so strong in taste. In some years half a million of these fishes have been sold from the neighbourhood of Mortlake, for the Dutch cod and turbot fishery, at the rate of two pounds per thousand. In many parts of Germany they are fried and packed up in barrels with spices and bay leaves, and are conveyed to very distant regions, where they are in high estimation, and sell for considerable prices. These fishes will live many days out of the water. In Russia they are taken from beneath the ice, packed in snow and exported to great distances, and will generally recover themselves on being afterwards thrown into the water. The planer lamprey is ten inches long, will live immersed in spirits of wine for fourteen minutes, moving during that time with incessant violence. The leech lamprey is a native of the river Seine, and will fix on the bellies of various fishes, particularly the shad, sucking their blood.

PETTY, (Sir William), a singular instance of a universal genius, was the elder son of Anthony Petty, a clothier at Rumsey in Hampshire, where he was born in the year 1623. While a boy he took great delight in spending his time among the artificers, whose trades he could work at when but 12 years of age. At the age of 15 he was master of the Latin, Greek, and French languages, with arithmetic and those parts of practical geometry and astronomy useful in navigation. Soon after he went to the University of Caen in Normandy; and after some stay there he returned to England, where he was preferred in the King's navy. In 1643, he went into the Netherlands and France for three years; and having vigorously prosecuted his studies, especially in physic, at the Universities of Utrecht, Leyden, Amsterdam, and Paris, he returned home. In 1647, he obtained a patent to teach the art of double writing for seventeen years. In 1648, he published at London, "Advice to Mr. Samuel Hartlib, for the advancement of some particular parts of learning." At this time he adhered to the prevailing party of the nation; and went to Oxford, where he taught anatomy and chemistry, and was created a Doctor of Physic, and grew into such repute that the philosophical meetings, which preceded and laid the foundation of the Royal Society, were first held at his house. In 1650, he was made Professor of Anatomy there; and soon after a member of the College of Physicians in London, as also Professor of Music at Gresham College, London. In 1652, he was appointed Phy-

sician to the army in Ireland; as also to three Lord Lieutenants, successively, Lambert, Fleetwood, and Henry Cromwell. In Ireland he acquired a great fortune, but not without suspicions and charges of unfair practices in his offices. After the rebellion was over in Ireland, he was appointed one of the Commissioners for dividing the forfeited lands to the army who suppressed it. When Henry Cromwell became Lieutenant of that kingdom, in 1655, he appointed Dr. Petty his Secretary, and Clerk of the Council: he likewise procured him to be elected a burgess for West Loo in Cornwall, in Richard Cromwell's parliament, which met in January, 1658. But, in March following, Sir Hierom Sankey, member for Woodstock in Oxfordshire, impeached him of high crimes and misdemeanors in the execution of his office. This gave the doctor a great deal of trouble, as he was summoned before the House of Commons; and notwithstanding the strenuous endeavours of his friends, in their recommendations of him to Secretary Thurloe, and the defence he made before the House, his enemies procured his dismission from his public employments, in 1659. He then retired to Ireland till the restoration of King Charles the Second; soon after which he came into England, where he was very graciously received by the King, resigned his professorship at Gresham College, and was appointed one of the Commissioners of the Court of Claims. Likewise, April the 11th, 1661, he received the honour of knighthood, and the grant of a new patent, constituting him Surveyor General of Ireland, and was chosen a member of parliament there.

Upon the incorporating of the Royal Society, he was one of the first members, and of its first council. And though he had left off the practice of physic, his name was continued as an honorary member of the College of Physicians in 1663. About this time he invented his double-bottomed ship, to sail against wind and tide, and afterwards presented a model of this ship to the Royal Society; to whom also, in 1665, he communicated "A Discourse about the Building of Ships," containing some curious secrets in that art. But, upon trial, finding his ship failed in some respects, he at length gave up that project.

In 1666, Sir William drew up a treatise, called "Verbum Sapienti," containing an account of the wealth and expenses of England, and the method of raising taxes in the most equal manner. He was well acquainted with the general principles of political arithmetic, and studiously promoted many projects highly useful to his country. It must, however, be admitted that he was equally attentive to his own interests. Thus, at sixty, he writes that his thoughts were fixed upon improving his lands in Ireland, and to promote the trade of iron, lead, marble, fish, &c. of which his estate is capable. As for studies and experiments, "I think now," says he, "to confine the same to the anatomy of the people, and political arithmetic; as also the improvement of ships, land carriages, guns, and pumps, as of most use to mankind." He died in December, 1687, leaving behind him wealth to the amount of about 15,000*l.* per annum. His works were very numerous, some of which are well known, and frequently referred to by authors in the present day.

PETTY *bag*, an office in Chancery, the three clerks of which record the return of all inquisitions out of every county, and make all patents of comptrollers, gaugers, customers, &c.

PETUNSE, in the arts, one of the principal substances made use of in the manufacture of porcelain: the other is kaolin. Petunse consists of

Silex	74
Alumina	14.5
Lime	5.5
	94.0

Kaolin consists of

Silex	74
Alumina	16.5
Lime	2
Water	7
	99.5

Therefore the two together consist of silex and alumina, with less than 5 per cent of lime. See PORCELAIN.

PEUCEDANUM, in botany, *sulphur-wort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit ovate, striated on both sides, girt with a membrane; involucres very short. There are eleven species, of which P. officinale, common sulphur wort, has a perennial root, dividing into many strong fibres, running deep into the ground; leaves from the root branching into five parts, and these again

into three, each of these divisions sustaining three narrow leaflets, which, when bruised, emit a strong scent like sulphur; foot-stalks channelled; stems nearly two feet in height, channelled, and dividing into two or three branches, each terminated by a large, regular umbel of yellow flowers, composed of several small umbels. It is a native of the southern parts of Europe, in moist meadows.

PEWTER, a factitious metal, used in making domestic utensils, as plates, dishes, &c. The basis of this metal is tin, which is converted into pewter, by mixing at the rate of an hundred weight of tin, with fifteen pounds of lead, and six pounds of brass. Besides this composition, which makes the common pewter, there are other kinds compounded of tin, regulus of antimony, bismuth and copper, in several proportions.

PEZIZA, in botany, a genus of the Cryptogamia Fungi class and order. Generic character: fungus bell-shaped, sessile, concealing lens-shaped seed-bearing bodies; plant concave; seeds on the upper surface only; discharged by jerks. Of this genus of fungus, Linnæus has eleven species, and Dr. Withering no less than forty British species in his arrangement.

PHACA, in botany, *bastard vetch*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: legume half, two-celled. There are eleven species.

PHÆTHUSA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Essential character: calyx sub-cylindric, many-leaved, with unequal, recurved scales; florets hermaphrodite, several in the disk; females one or two in the ray; receptacle chaffy; seeds hispid, without any proper down. There is but one species, viz. P. Americana, a native of Virginia.

PHÆTON, the *Tropic bird*, in natural history, a genus of birds of the order Anseres. Generic character: bill sharp-edged and pointed; compressed, and slightly sloping down; nostrils pervious and oblong; four toes all webbed together; tail wedge-formed, the two middle feathers extending far beyond others. There are three species: P. æthereus, the common tropic bird, is of the size of a wigeon, and the two middle feathers of the tail measure a foot and a half at least. These birds are always found within, or at least very near the tropics. They frequently soar to a prodigious height, but generally are near the surface of the water, watching the movements of the flying fish, whose escape from the pursuit of the shark, porpoise, and other enemies beneath, is attended with destruction from the frigate, or man of war bird, the pelican, and tropic bird above. They occasionally repose upon the backs of the drowsy tortoises, as the latter float upon the water, and in these circumstances, are taken with the greatest ease. They build in the woods, and will perch on trees. They shed their long feathers every year, and the natives of the Sandwich islands where the tropic birds abound, pick them up in great abundance in various parts, and consider them as an elegant material in their curious and elaborate dresses, particularly in their mourning suits. These birds are not admired for food.

PHALANGIUM, in natural history, a genus of insects of the order Aptera. Mouth with horny mandibles, the second joint with a sharp, moveable, cheliferous tooth; feelers filiform; no antennæ; two eyes on the crown, and two at the sides; eight legs; abdomen generally rounded. Of all the insects in this order, few are more repulsive than those of the Phalangium genus, of which there are about twenty species. Some of them are armed with weapons resembling those of the spider genus, but operating with greater malignity. They differ in size, some being very minute, while others are equal in magnitude to the larger kind of spiders. This genus is divided into two sections. A. Mouth with a conic, tubular sucker. B. Mouth without a sucker. The former is sub-divided into sub-sections, *viz. a.* Four-feelers, the upper ones chelate. *b.* Two feelers. In the latter, there are two sub-sections, *viz. a.* Feelers projecting, incurved. *b.* Feelers thick, spinous, and furnished with a claw at the tip. P. reniforme, feelers serrate; fore-legs very long and filiform; thorax kidney-shaped: this is one of the largest of the genus: it is a native of the hotter regions of the globe, being found in Africa and South America. This insect is of a deep chesnut-brown colour, with a yellowish cast on the abdomen. All the insects of this genus, in their various stages of transformation, prey on the smaller insects and worms; the larva and pupa are active, eight-footed, and resemble the perfect insect. To this genus belong the well-known insects, called long-legged, shepherd, or harvest spiders, which, notwithstanding their common name, differ

very considerably from spiders properly so named. The most common insect of this kind, is the P. opilio of Linnæus, which, during the autumn, may be observed in gardens, about walls, &c.: it is remarkable for its plump, but flattish, orbicular body, and its long and slender legs, which are generally so carried, that the body appears suspended or elevated to a considerable height above the surface on which the animal rests. P. cancroides: abdomen obovate, depressed, ferruginous chelæ, or claws, oblong, hairy. This species differs considerably in size. It inhabits Europe, and is said to be the little insect which gets into our legs, and under the skin, causing a painful itching.

PHALARIS, in botany, *canary grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, keeled, the valves equal in length, inclosing the corolla. There are twelve species, of which P. canariensis, cultivated canary grass, has an annual root; the culm is from a foot to eighteen inches in height, upright, round, striated, swelling a little at the joints, at the lower ones frequently branching; leaves half an inch in breadth, of a lively green colour, the lower part of the leaf swells out like a spathe, completely involving, and protecting the head of flowers whilst young; this grass is a native of the Canary islands; it is also found in a wild state in many parts of Britain. The cultivation of it is chiefly confined to the isle of Thanet, where it is esteemed a profitable crop.

PHALENA, in natural history, the *moth*, a genus of insects of the order Lepidoptera. Generic character: antennæ gradually tapering from the base to the tip; wings, when at rest generally deflected: flight nocturnal. They fly abroad only in the evening and during the night, and feed on the nectar of flowers: the larva is active and quick in motion, mostly smooth, more or less cylindrical, and preys on the leaves of various plants: pupa quiescent, more or less cylindrical, pointed at the tip, or at both ends, and is generally inclosed in a follicle. This genus, contains a vast number of species, and is divided into assortments according to the different habits of the animals: these are,

1. Attaci, or those in which the wings, when at rest, are spread out horizontally.

2. Bombyces, in which the wings are incumbent and the antennæ pectinated.

3. Noctuæ, with incumbent wings setaceous antennæ.

4. Geometræ, with wings horizontally spread out, nearly as the attaci.

5. Tortrices, with very obtuse wings, curved on the exterior margin.

6. Pyralides, with wings converging into a deltoid, and slightly furcated figure.

7. Tineæ, with wings convoluted into a cylinder.

8. Alucitæ, with wings divided into distinct plumes.

Of all the European species of the first division the finest, by much, is P. junonia, a native of many parts of Germany, Italy, France, &c. but not yet observed in England. It measures about six inches in extent of wings, and is varied by a most beautiful assortment of the steady colours. The caterpillar which feeds on the apple, pear, &c. is hardly less beautiful than the insect itself, and, when ready for its change, it envelopes itself in an oval web with a pointed extremity, and transforms itself into a large short chrysalis, out of which emerges the moth. See Plate IV. Entomology, fig. 1.

P. peronia, minor peacock moth, is a native of England, and is commonly called the emperor moth.

Of the bombyces we must notice the P. caja, or great tiger-moth, which is one of the largest English moths, and is of a fine cream colour, with chocolate-brown bars and spots, the lower wings red, with black spots; the thorax chocolate brown, with a red collar round the neck, and the body red with black bars. The caterpillar is of a deep brown, with white specks, very hairy, and feeds on various plants.

P. vinula is remarkable for elegance of appearance without gaiety of colour, being a middle-sized white moth, variegated with numerous small black streaks, and specks: the thorax and abdomen are extremely downy, and the body is marked by transverse black bars. The caterpillar of this moth is far more brilliant in its appearance than the complete animal; it is of considerable size, measuring above two inches in length, and is of a most beautiful green colour, with the back of a dull purple, freckled with very numerous deeper streaks in a longitudinal direction: this purple part of the back is separated from the green on the sides by a pair of milk-white stripes, which commencing from the head, run upwards to the top of the back; that part being elevated considerably above the rest

into a pointed process; and from thence are continued along the sides to the tail: the face is flat, and subtriangular, yellowish, surrounded first by a black, and then by a red border; and is distinguished by two deep black eyes or spots on each side the upper part: from the tail, which is extended into two long, roughened, sharp-pointed, tubular processes, proceed on the least irritation, two long, red, flexible tentacula, the animal seeming to exert them as if for the purpose of terrifying its disturbers; lifting up the fore-part of the body at the same time, in a menacing attitude, and presenting a highly grotesque appearance: it also possesses the power of suddenly ejecting from its mouth, to a considerable distance, an acrimonious reddish fluid, which it uses as a further defence, and which produces considerable irritation, if it happens to be thrown into the eyes of the spectator. This caterpillar is principally seen on willows and poplars, and when the time of its change arrives, descends to the lower part of the tree, and envelopes itself in a glutinous case, prepared by moistening with its saliva the woody fibres of the tree, and covering itself with them, attaching the edges very closely to the bark: this case, having very much the colour of the bark itself, is not very conspicuous, so that the insect generally remains secure under its covering throughout the whole winter, it being too close to be penetrated by the frost, and too strong to be successfully attacked by birds, &c. it requires even a very sharp knife, assisted by a strong hand, to force it open. The chrysalis is thick, short, and black, and in the month of May or June, according to the warmth or coolness of the season, gives birth to the moth, which, immediately on emerging from the upper part of the chrysalis, discharges a quantity of fluid sufficient to soften effectually the walls of its prison, and effect a ready escape. This moth, from its unusually downy appearance, has obtained the popular title of the puss moth.

But of all the moths of the tribe Bombyx, the P. mori, or silkworm moth, is by far the most important. This is a whitish moth, with a broad pale brown bar across each of the upper wings. The caterpillar or larva, emphatically known by the title of the silkworm, is, when full grown, nearly three inches long, and of a yellowish grey colour; on the upper part of the last joint of the body is a horn-like process, as in many of the sphinges. It feeds, as every one knows, on the leaves of the white mulberry, in defect of which may be substituted the black mulberry, and even, in some instances the lettuce, and a few other plants. The silkworm remains in its larva state about six weeks, changing its skin four times during that period, and, like other caterpillars, abstaining from food for some time before each change. When full grown the animal entirely ceases to feed, and begins to form itself a loose envelopement of silken fibres in some convenient spot which it has chosen for that purpose, and afterwards proceeds to enwrap itself in a much closer covering, forming an oval yellow silken case or ball about the size of a pigeon's egg, in which it changes to a chrysalis, and after lying thus inclosed for the space of about fifteen days, gives birth to the moth. This, however, is always carefully prevented when the animals are reared for the purpose of commerce, the moth greatly injuring the silk of the ball by discharging a quantity of coloured fluid before it leaves the cell; the silk balls are therefore exposed to such a degree of heat as to kill the inclosed chrysalides, a few only being saved for the breed of the following year. The moth, when hatched, is a very short-lived animal, breeding soon after its exclusion, and when the females have laid their eggs, they, as well as the males, survive but a very short time.

As an example of the Geometræ, we may adduce a very elegant moth, often seen towards the middle of summer on the elder, and called P. sambucaria; it is moderately large, of a pale sulphur colour, with angular wings, marked by a narrow transverse brown line or streak. It proceeds from a green caterpillar, which, like those of the rest of this section, walks in a peculiar manner, *viz.* by raising up the body at each progressive movement into the form of an arch or loop, the extremities nearly approaching each other. It changes in May and June into a black chrysalis, out of which in June or July, proceeds the moth.

The division called Tineæ comprehends those moths which are, in general, of a small size, though often of very elegant colours. Of this tribe is the P. padella: it is of a pearly white colour, with very numerous black spots: its caterpillar is gregarious, appearing in great quantities on various sorts of fruit trees during the decline of summer, and committing great ravages on

the leaves: these caterpillars inhabit a common web, and usually move in large groups together; their colour is a pale greyish yellow, with numerous black spots; each caterpillar at the time of its change to chrysalis, envelopes itself in a distinct oval web with pointed extremities, and many of these are stationed close to each other, hanging in a perpendicular direction from the internal roof of the general inclosing web: the chrysalis is blackish, and the moth appears in the month of September. To this division also belong the moths, emphatically so called, or cloth moths. Of these the principal is the P. vestianella, which, in its caterpillar state, is very destructive to woollen cloths, the substance of which it devours, forming for itself a tubular case with open extremities, and generally approaching to the colour of the cloth on which it is nourished. This mischievous species changes into a chrysalis in April, and the moth, which is universally known, appears chiefly in May and June.

In the last division, called Alucitæ, is one of the most elegant of the insect tribe, though not distinguished either by large size or lively colours. It is a small moth, of a snowy whiteness, and, at first view, catches the attention of the observer by the very remarkable aspect of its wings, which are divided into the most beautiful distinct plumes, two in each upper, and three in each under wing, and formed on a plan resembling that of the long wing feathers of birds, *viz*, with a strong middle rib or shaft, and innumerable lateral fibres. This moth, which is the P. pentadactyle of Linnæus, appears chiefly in the month of August. Its caterpillar, which is yellowish green, speckled with black, feeding on nettles, and changing into a blackish chrysalis enveloped in a white web.

PHARMACY. This is a very important branch of therapeutic science, which in the article on MATERIA MEDICA we have observed, embraces the three divisions of medicinal materials, the preparation of those materials, and the diseases in which they are employed. Pharmacy includes the second of these divisions; and is, hence, the doctrine of preserving, arranging, compounding, and intermixing the different articles of the Materia Medica, so that as simple substances we may obtain their virtues in the most active or most convenient form, and, in a state of combination, redouble or vary their powers according to the intention we have in view. In prosecuting this object, a multiplicity of operations are necessary, some of them mechanical, some chemical, which constitute the means by which the result is to be attained; and under this natural division, the means and the end, pharmaceutical operations, and pharmaceutical preparations, we shall consider the subject before us.

PART I.

PHARMACEUTICAL OPERATIONS.

Under this head we shall comprise the mode of collecting and preserving medicinal simples; the mechanical instruments employed, and the changes they introduce; chemical instruments and apparatus, their use, application, and power.

Collection and Preservation of Simples.

Each of the kingdoms of nature furnishes articles employed in medicine in their natural state, or when prepared by pharmacy; and in collecting these our first attention should be to make choice of sound and perfect substances; to throw off whatever is injured or decayed, and to separate them from all adventitious matters. As a general rule they must be defended from the effects of moisture, great heat, cold, and freely exposed to the air. Yet when their activity and virtue depend on volatile principles, instead of being freely exposed to the air, they must be confined, as much as possible, from its contact.

The vegetable kingdom affords us the most numerous articles; these should rather be obtained from countries in which they grow naturally, than countries in which they merely grow by transplantation; and those which grow wild, in dry soils, and exposed situations, fully open to the air and the sun, are for the most part to be preferred to plants that are cultivated, or that grow in moist, low, shady, and confined situations. Annual roots should be collected before they shoot forth their stalks or flowers; biennial roots in the harvest of their first year, or the spring-time of their second; perennial roots either in the spring time before the sap has begun to mount, or in harvest after it has returned. Worm-eaten or decayed roots, except in a few cases of resinous plants, are to be rejected; the rest are to be cleaned immediately with a brush of cold water; immersing them in the water as short a time as possible, and cutting off the radicles and fibres when not essential. Roots which consist chiefly of

fibres, and have but a small sap, may be dried at once; if juicy and not aromatic in a heat somewhat below 100° of Fahrenheit; but if aromatic by simply exposing them to a current of cold dry air, and frequently turning them in it. If very thick and strong, they must be split and cut into slices, and strung upon threads; if covered with a tough bark they may be peeled and dried while fresh. Such as lose their virtues by drying are to be kept buried in dry sand.

It is difficult to lay down general rules for collecting stalks and leaves, some of which acquire, while others lose their activity by age. Aromatics should be collected after the flower-buds are formed; non-aromatics if annuals, when in flower, or about to flower; biennials before they shoot; and perennials before they flower, especially the woody-fibred. They should be gathered in dry weather, after the morning dew is off, or before it falls in the evening. Generally speaking, they should be tied in bundles, and hung up in a shady, warm, and airy place, or spread upon the floor, and frequently turned. If very juicy, they are to be laid upon a sieve, and dried by a gentle degree of artificial warmth. Sprouts are to be collected before the buds open; and stalks to be gathered in autumn. Barks are to be collected when the most active parts of the vegetable are concentrated in them. Spring is preferred for resinous barks, and autumn for the others which are rather gummy than resinous. Young trees afford the best bark for medical purposes.

The same rules apply to the collection of woods; but they must not be taken from very young trees. Among the resinous woods, the heaviest, which sink in water, are selected. The alburnum is to be rejected.

Flowers are collected in clear dry weather, before noon, but after the dew is off; either when they are just about to open, or immediately after they have opened. Of some the petals only are preserved, and the colourless claws are even cut away; of others whose calyx is odorous, the whole flower is kept. Flowers which are too small to be pulled singly, are dried with part of the stalk: these are called heads or tops.

Flowers are to be dried nearly as leaves, but more quickly, and with more attention. As they must not be exposed to the sun, it is best done by a slight degree of artificial warmth. When they loose their colour and smell they are unfit for use.

Seeds and fruits, unless when otherwise directed, are to be gathered when ripe, but before they fall spontaneously. Some pulpy fruits are freed from their core and seeds, strung upon thread, and dried artificially. They are in general best preserved in their natural coverings, although some, as the colocynth, are peeled, and others, as the tamarind, preserved fresh. Many of these are apt to spoil, or become rancid; and as they are then no longer fit for medical use, no very large quantity of them should be collected at a time.

The proper drying of vegetable substances is of the greatest importance. It is often directed to be done in the shade, and slowly, that the volatile and active particles may not be dissipated by too great heat; but this is an error, for they always lose infinitely more by slow than by quick drying. When, on account of the colour, they cannot be exposed to the sun, and the warmth of the atmosphere is insufficient, they should be dried by an artificial warmth, less than 100° Fahrenheit, and well exposed to a current of air. When perfectly dry and friable, they have little smell; but after being kept some time, they attract moisture from the air, and regain their proper odour.

The boxes and drawers in which vegetable matters are kept, should not impart to them any smell or taste; and more certainly to avoid this, they should be lined with paper. Such as are volatile, of a delicate texture, or subject to suffer from insects, must be kept in well covered glasses. Fruits and oily seeds, which are apt to become rancid, must be kept in a cool, and dry, but by no means in a warm or moist place.

Oily seeds, odorous plants, and those containing volatile principles, must be collected fresh every year. Others, whose properties are more permanent, and not subject to decay, will keep for several years. Vegetables collected in a moist and rainy season are in general more watery and apt to spoil. In a dry season, on the contrary, they contain more oily and resinous particles, and preserve much better.

Mechanical Operations.

These consist of the mode of determining the weight or measure of bodies; their division into minute particles; their separation of part from part, or of the useful

from the useless; the modes of intermixing them.

Weights and Measures. The quantities of substances employed as medicines are determined with the greatest accuracy by weighing. The scales should balance with the utmost precision, and turn with the utmost facility. Balances should be defended as much as possible from acid and other corrosive vapours, and not be unnecessarily suspended, as their delicacy of decision is hereby much impaired; and to guard against this last evil in another way, they should never be over loaded.

The want of an uniformity of weights and measures which is felt in every country, and in every branch of trade and commerce, is of peculiar inconvenience in pharmacy. All our college pharmacopoeias command the use of troy weight; yet the wholesale druggists in every instance, excepting where a very small portion of an article is bought by grains, scruples, or drachms, sell by avoirdupoise weight; and there is reason to fear that, both amongst apothecaries and druggists, most of the pharmaceutic compositions are prepared by this last division; in consequence of which it is impossible for the physician to know the exact strength of the dose he prescribes, and if he do, he cannot often obtain it in the proper proportions of its respective ingredients. The difficulty is still increased by a promiscuous use of weights and measures, in determining the quantities of fluids, on which account, though the London college still authorises both for distinct purposes, the colleges of Edinburgh and Dublin have rejected measures altogether.

For measuring fluids, the graduated glass measures are always to be preferred: they should be of different sizes, according to the quantities they are intended to measure. Elastic fluids are also measured in glass tubes, graduated by inches and their decimals.

Specific gravity is the weight of a determinate bulk of any body. For a standard of comparison distilled water has been assumed as unity. The specific gravity of solids is ascertained by comparing the weight of the body in the air with its weight when suspended in water. The quotient obtained by dividing its weight in air by the difference between its weight in air and its weight in water, is its specific gravity. The specific gravity of fluids may be ascertained by comparing the loss of weight of a solid body, such as a piece of crystal, when immersed in distilled water, with its loss when immersed in the fluid we wish to examine; by dividing its loss of weight in the fluid by its loss of weight in the water, the quotient is the specific gravity of the fluid: or a small phial, containing a known weight of distilled water, may be filled with the fluid to be examined and weighed, and by dividing the weight of the fluid by the weight of the water, the specific gravity is ascertained.

Although these are the only general principles by which specific gravities are ascertained, yet as the result is always influenced by the state of the thermometer and barometer at the time of the experiments, and as the manipulation is a work of great nicety, various ingenious instruments have been contrived to render the process and calculation easy. Of all these, the gravimeter of Morveau seems to deserve the preference.

It would be of material consequence to science and the arts, if specific gravities were always indicated by the numerical term expressing their relation to the specific gravity of distilled water. This, however, is unfortunately not the case. The excise officers in this country collect the duties paid by spiritous liquors, by estimating the proportion which they contain of a standard spirit, about 0.933 in specific gravity, which they call hydrometer proof, and they express the relation which spirits of a different strength have to the standard spirit by saying that they are above or under hydrometer proof. Thus one to six, or one in seven below hydrometer proof means that it is equal in strength to a mixture of six parts of proof spirit with one of water.

The only other mode of expressing specific gravities which it is necessary to notice is that of Baumè's areometer, as it is often used in the writings of the French chemists, and is little understood in this country. For substances heavier than water he assumes the specific gravity of distilled water as zero, and graduates the stem of his instrument downwards, each degree being supposed by him to express the number of parts of muriate of soda contained in a given solution, which however is not at all the case. For substances lighter than water the tube is graduated upwards, and this zero is afforded by a solution of 10 of salt in 90 water.

Mechanical Division. By this process substances are reduced to a form better

adapted for medical purposes; and by the increase of their surface their action is promoted, both as medical and chemical agents. It is performed by cutting, bruising, grinding, grating, rasping, filing, pulverization, trituration, and granulation, by means of machinery or of proper instruments.

Pulverization is the first of these operations that is commonly employed in the apothecary's shop. It is performed by means of pestles and mortars. The bottom of the mortars should be concave; and their sides should neither be so inclined as not to allow the substances operated on to fall to the bottom between each stroke of the pestle, nor so perpendicular as to collect it too much together, and to retard the operation. The materials of which the pestles and mortars are formed should resist both the mechanical and chemical action of the substances for which they are used. Wood, iron, marble, siliceous stones, porcelain, and glass, are all employed: but copper, and metals containing copper, are to be avoided. They should be provided with covers, to prevent the finest and lightest parts from escaping, and to defend the operator from the effects of disagreeable or noxious substances. But these ends are more completely attained by tying a piece of pliable leather round the pestle and round the mouth of the mortar. It must be closely applied, and at the same time so large, as to permit the free motion of the pestle. In some instances it will be even necessary for the operator to cover his mouth and nostrils with a wet cloth, and to stand with his back to a current of air, that the very acrid particles which arise may be carried from him. The addition of a little water or spirit of wine, or of a few almonds, to very light and dry substances, will prevent their flying off. But almonds are apt to induce rancidity, and powders are always injured by the drying which is necessary when they have been moistened. Water must never be added to substances which absorb it, or are rendered cohesive by it.

All vegetable substances must be previously dried. Resins and gummy resins, which become soft in summer, must be powdered in very cold weather, and must be beaten gently, or they will be converted into a paste instead of being powdered. Wood, roots, barks, horn, bone, ivory, &c. must be previously cut, split, chipped, or rasped. Fibrous woods and roots should be finely shaved after their bark is removed, for otherwise their powders will be full of hair-like filaments, which can scarcely be separated. Some substances will even require to be moistened with mucilage of tragacanth, or of starch, and then dried before they can be powdered. Camphor may be conveniently powdered by the addition of a little spirit of wine, or almond oil. The emulsive seeds cannot be reduced to powder unless some dry powder be added to them. To aromatic oily substances sugar is the best addition. All impurities and inert parts having been previously separated, the operation must be continued and repeated upon vegetable substances till no residuum is left. The powders obtained at different times must then be intimately mixed together, so as to bring the whole to a state of perfect uniformity.

Very hard stony substances must be repeatedly heated to a red heat, and then suddenly quenched in cold water, until they become sufficiently friable. Some metals may be powdered hot in a heated iron mortar, or may be rendered brittle by alloying them with a little mercury.

Trituration is intended for the still more minute division of bodies. It is performed in flat mortars of glass, agate, or other hard materials, by giving a rotatory motion to the pestle; or on a levigating stone, which is generally of porphyry, by means of a muller of the same substance. On large quantities it is performed by rollers of hard stone, turning horizontally upon each other, or by one vertical roller turning on a flat stone.

The substances subjected to this operation are generally previously powdered or ground.

Levigation differs from trituration only in the addition of water or spirit of wine to the powder operated upon, so as to form the whole mass into a kind of paste, which is rubbed until it be of sufficient smoothness or fineness. Earths and some metallic substances are levigated.

Granulation is employed for the mechanical division of some metals. It is performed, either by stirring the melted metal with an iron rod until it cools, or by pouring it into water, and stirring it continually as before, or by pouring it into a covered box, previously well rubbed with chalk, and shaking it until the metal cools, when the rolling motion will be converted into a rattling one. The adhering chalk is then to be washed away.

Mechanical Separation is obtained by sift-

ing, elutriation, decantation, filtration, despumation, expression.

Sifting. From dry substances, which are reduced to the due degree of minuteness, the coarser particles are to be separated by sieves of iron-ware, hair-cloth, or gauze, or by being dusted through bags of fine linen. For very light and valuable powders, or acrid substances, compound sieves, having a close lid and receiver must be used. The particles which are not of sufficient fineness to pass through the interstices of the sieve, may be again powdered.

Elutriation is confined to mineral substances, on which water has no action. It is performed by separating them from foreign particles and impurities, of a different specific gravity, in which case they are said to be washed; or for separating the impalpable powders, obtained by trituration and levigation from the coarser particles. This process depends upon the property that very fine or light powders have of remaining for some time suspended in water; and is performed by diffusing the powder or paste formed by levigation through plenty of water, letting it stand a sufficient time, until the coarser particles settle at the bottom; and then pouring off the liquid in which the finer or lighter particles are suspended. Fresh water may be poured on the residuum, and the operation repeated; or the coarser particles, which fall to the bottom, may be previously levigated a second time.

Decantation. The fine powder which is washed over with the water is separated from it, by allowing it to subside completely and by either decanting off the water very carefully, or by drawing it off by a syringe or syphon. These processes are very frequently made use of for separating fluids from solids which are specifically heavier, especially when the quantity is very large, or the solid so subtile as to pass through the pores of most substances employed for filtration, or the liquid so acrid as to corrode them.

Filtration. For the same purpose of separating fluids from solids, straining and filtration are often used. These differ only in degree, and are employed when the powder either does not subside at all, or too slowly and imperfectly for decantation. The instruments for this purpose are of various materials, and must in no instance be acted upon by the substances for which they are employed. Fats, resins, wax, and oils, are strained through hemp or flax spread evenly over a piece of wire-cloth or net stretched in a frame. For saccharine and mucilaginous liquors, fine flannel may be used: for some saline solutions, linen. Where these are not fine enough, unsized paper is employed; but it is extremely apt to burst by hot watery liquors which dissolve its size; and very acrid liquors, such as acids, are filtered by means of a glass-funnel, filled with powdered quartz, a few of the larger pieces being put into the neck, smaller pieces over these, and the finer powder placed over all. The porosity of this last filter retains much of the liquor; but it may be recovered by gently pouring on it as much distilled water; the liquor will then pass through, and the water be retained in its place.

Water may be filtered in large quantities through basins of porous stone, or artificial basins of nearly equal parts of fine clay and coarse sand. The size of the filters depends on the quantity of matter to be strained. When large, the flannel or linen is formed into a conical bag, and suspended from a hoop or frame; the paper is either spread on the inside of these bags, or folded into a conical form, and suspended by a funnel. It is of advantage to introduce glass rods, or quill-barrels, between the paper and funnel, to prevent them from adhering too closely. What passes first is seldom fine enough, and must be poured back again, until by the swelling of the fibres of the filter, or filling up of its pores, the fluid acquires the requisite degree of limpidity. The filter is sometimes covered with charcoal powder, which is a useful addition to muddy and deep-coloured liquors. The filtration of some viscid substances is much assisted by heat.

Expression is a species of filtration, assisted by mechanical force. It is principally employed to obtain the juices of fresh vegetables, and the unctuous vegetable oils. It is performed by means of a screw press with plates of wood, iron, or tin. The subject of the operation is previously beaten, ground, or bruised. It is then inclosed in a bag, which must not be too much filled, and introduced between the plates of the press. The bags should be of hair-cloth, or canvass inclosed in hair-cloth. Hempen and woollen bags are apt to give vegetable juices a disagreeable taste. The pressure should be gentle at first, and increased gradually. Vegetables intended for this operation should be perfectly fresh and freed from all impurities. In general they should be expressed as soon as they are bruised, for it disposes them to ferment;

but subacid fruits give a larger quantity of juice and of finer quality, when they are allowed to stand some days in a wooden or earthen vessel after they are bruised. To some vegetables which are not juicy enough of themselves, the addition of a little water is necessary. Lemons and oranges must be peeled, as their skins contain a great deal of essential oil, which would mix with the juice. The oil itself may be obtained separately, by expression with the fingers against a plate of glass.

For unctuous seeds iron plates are used; and it is customary not only to heat the plates, but to warm the bruised seeds in a kettle over the fire, after they have been sprinkled with some water, as by these means the product is increased, and the oil obtained is more limped. But as their disposition to rancidity is increased by it, if possible this practice should be laid aside, or confined to exposing the bruised seeds, inclosed in a bag, to the steam of hot water.

Despumation is generally practised on thick and clammy liquors, which contain much slimy and other impurities, not easily separable by filtration. The scum arises either by simply heating the liquor, or by clarifying it, which is done by mixing with the liquor, when cold, whites of eggs well beaten with a little water, which on being heated coagulates, and entangling the impurities of the liquor, rises with them to the surface, and may be easily removed by a perforated ladle; or the liquor may now be filtered with ease. Spirituous liquors are clarified by means of isinglass dissolved in water, or any albuminous fluid, such as milk, which coagulates by the action of alcohol without the assistance of heat. Some expressed juices, such as those of the antiscorbutic plants, are instantly clarified by the addition of vegetable acid, such as the juice of bitter oranges.

Fluids can only be separated from each other when they have no tendency to combine, and when they differ in specific gravity. The separation may be effected by skimming off the lighter fluid with a silver or glass spoon; or by drawing it off by a syringe or syphon; or by means of a glass separatory, which is an instrument having a projecting tube, terminating in a very slender point, through which the heavier fluid alone is permitted to run; or by means of the capillary attraction of a spongy woollen thread; for no fluid will enter a substance whose pores are filled by another, for which it has no attraction; and, lastly, upon the same principle, by means of a filter of unsized paper, previously soaked in one of the fluids, which in this way readily passes through it, while the other remains behind.

Mechanical mixture is performed by agitation, trituration, or kneading; but these will be best considered in treating of the forms in which medicines are exhibited.

Chemical Operations and Results.

Under this chapter we have to consider the apparatus employed, the changes produced, and the general analyses that ensue.

The apparatus consists of vessels, fuel, or heat; and the different modes by which such fuel or heat is applied, whether lamps, furnaces, &c.

The vessels must necessarily vary in their form and materials; upon the first of which it will be more convenient to enlarge as we proceed to treat of the particular operations in which they are employed. In choosing the materials for the construction of our vessels, the properties most generally required are a power of resisting chemical agents, transparency, compactness, strength, fixity, and infusibility, and an ability to sustain sudden variations of temperature without breaking.

Generally speaking, metals possess the four last properties in considerable perfection; but they are all opaque. Iron and copper are apt to be corroded by chemical agents; and a solution of the last is often followed by dangerous affections. Tinning them will sometimes, but not always, answer; for tin and lead are often too fusible. Platinum, gold, and silver, resist most of the chemical agents, but are too expensive for general use.

Good earthenware resists the greatest intensity of heat, but has no other property to recommend it. Clay, the basis of all such wares, is plastic when worked with water, and sufficiently hard when burnt with an intense heat. But intense heat contracts it unduly, and it is apt to split and crack upon exposure to sudden changes of temperature; whence it is necessary to counteract this property by the addition of some other substance. Siliceous sand, clay reduced to powder, and then burnt with a very intense heat, and plumbago, are occasionally used. These additions, however, are attended with other inconveniences; plumbago especially is liable to combustion, and sand diminishes the compactness; so that when not glazed they are porous, and

when glazed they are acted upon by chemical agents. The chemical vessels manufactured by Messrs. Wedgewood are the best of this description, except porcelain, which is too expensive.

Glass possesses the three first qualities in an eminent degree, and may be heated red-hot without melting. Its greatest inconvenience is its disposition to crack or break in pieces when suddenly heated or cooled. As this is occasioned by its unequal expansion or contraction, it is best remedied by forming the vessels very thin, and giving them, in general, a rounded shape. Glass vessels should also be well annealed, that is, cooled very slowly, after being blown, by placing them immediately in an oven while they are yet in a soft state. When ill annealed, or cooled suddenly, glass is apt to fly in pieces on the slightest change of temperature, or touch of a sharp point. We may sometimes take advantage of this imperfection; for by means of a red-hot wire glass vessels may be cut into any shape. Where there is not a crack already in the glass, the point of the wire is applied near the edge, by which a crack is formed; and this is afterwards easily led in any direction we wish.

Reaumur's porcelain is also glass, which, by being surrounded with hot sand, is made to cool so slowly that it assumes a crystalline texture that destroys its transparency, but imparts to it every other quality desirable in chemical vessels. The coarser kinds of glass are commonly used in making it; but as there is no manufacture of this valuable substance, its employment is still very limited.

Lutes also form a necessary part of chemical apparatus. They are compositions of various substances, intended to close the joining of vessels, to coat glass vessels, and to line furnaces. Lutes of the first description are commonly employed to confine elastic vapours. They should, therefore, possess the following properties: viscidity, plasticity, compactness, the power of resisting acrid vapours, and certain degrees of heat. The viscidity of lutes depends on the presence either of unctuous or resinous substances, mucilaginous substances, or clay.

Lutes of the first kind possess viscidity, and resist acrid vapours in an eminent degree; but they are in general so fusible, that they cannot be employed when they are exposed even to very low degrees of heat, and they will not adhere to any substance that is at all moist. The following are a few of this kind that have been most frequently employed:

Eight parts of yellow wax melted with one of oil of turpentine, with or without the addition of resinous substances, according to the degree of pliability and consistence required. Lavoisier's lute.

Four parts of wax melted with two of varnish and one of olive oil. Saussure's lute.

Three parts of powdered clay worked up into a paste, with one of drying oil, or, what is better, amber varnish. The drying oil is prepared by boiling 22.5 parts of litharge in 16 of linseed oil, until it be dissolved. Fat lute.

Chalk and oil, or glaziers' putty, is well fitted for luting tubes permanently into glass vessels, for it becomes so hard that it cannot be easily removed.

Equal parts of litharge, quick-lime, and powdered clay, worked into a paste with oil varnish, is sometimes used to daub over the cracks in glass vessels, so as to render them again fit for some purposes.

Melted pitch and brick dust.

Mucilaginous substances, such as flour, starch, gum, and glue mixed with water, with or without some powder, are sufficiently adhesive, are dried by moderate degrees of heat, and are easily removed after the operation, by moistening them with water. But a high temperature destroys them, and they do not resist corrosive vapours. Of these take the following forms:

Slips of bladder macerated in water, and applied with the inside next the vessels. They are apt, however, from their great contraction on drying, to break weak vessels.

One part of gum arabic with six or eight of chalk, formed into a paste with water.

Flour worked into a paste with powdered clay or chalk.

Almond or linseed meal formed into a paste with mucilage or water.

Quicklime in fine powder, hastily mixed with white of egg, and instantly applied, sets very quickly, but becomes so hard that it can scarcely be removed.

Slaked lime in fine powder, with glue, does not set so quickly as the former.

The cracks of glass vessels are sometimes mended by daubing them and a suitable piece of linen over with white of egg, strewing both over with finely powdered quick lime, and instantly applying the linen closely and evenly.

Earthy lutes resist very high tempera-

tures, but they become so hard that they can scarcely be removed, and often harden so quickly after they are mixed up, that they must be applied immediately. Examples:

Quick-lime well incorporated with a sixth part of muriate of soda.

Burnt gypsum, made up with water.

One ounce of borax dissolved in a pound of boiling water, mixed with a sufficient quantity of powdered clay. Mr. Watts's fire lute.

One part of clay with four of sand formed into a paste with water. This is also used for coating glass vessels, in order to render them stronger and capable of resisting violent degrees of heat. It is then made into a very thin mass, and applied in successive layers, taking care that each coat be perfectly dry before another be laid on.

The lutes for lining furnaces will be described when treating of furnaces.

The junctures of vessels which are to be luted to each other, must previously be accurately and firmly fitted, by introducing between them, when necessary, short bits of wood or cork, or, if the disproportion be very great, by means of a cork fitted to the one vessel, having a circular hole bored through it, through which the neck of the other vessel or tube passes. After being thus fitted, the lute is either applied very thin, by spreading it on slips of linen or paper, and securing it with thread, or, if it is a paste lute, it is formed into small cylinders, which are successively applied to the junctures, taking care that each piece be made to adhere firmly and perfectly close in every part, before another is put on. Lastly, the whole is secured by slips of linen or bladder. In many cases, to permit the escape of elastic vapours, a small hole is made through the lute with a pin, or the lute is perforated by a small quill, fitted with a stopper.

Heat and Fuel. As caloric is an agent of the most extensive utility in the chemical operations of pharmacy, it is necessary that we should be acquainted with the means of employing it in the most economical and efficient manner. The rays of the sun are used in the drying of many vegetable substances, and the only attentions necessary are to expose as large a surface as possible, and to turn them frequently, that every part may be dried alike. They are also sometimes used for promoting spontaneous evaporation.

The combustion of different substances is a much more powerful and certain source of heat. The substances employed for this purpose, are either fluid or solid. Alcohol, oil, tallow, wood, turf, coal, charcoal, and coke, are all occasionally employed. Alcohol, oil, and melted tallow, fluid inflammables, must be burnt on porous wicks. These act merely mechanically, by drawing up a portion of the fluid to be volatilized and inflamed. They are therefore burnt in lamps of various constructions. But although commonly used to produce light, they afford a very uniform, though not very high temperature: it may, however, be increased by increasing the number of the wicks, and their size. Alcohol produces a steady heat, no soot, and, if strong, leaves no residuum. Oil gives a higher temperature, but on a common wick produces much smoke and soot. These are diminished, and the light and heat increased, by making the surface of the flame bear a large proportion to the centre, which is best done by a cylindrical wick, so contrived that the air has free access both to the outside and to the inside of the cylinder, as in Argand's lamp, invented by Mr. Boulton of Birmingham. In this way, oil may be made to produce a considerable temperature, of great uniformity, and without the inconvenience of smoke.

Wicks have the inconvenience of being charred by the high temperature to which they are subjected, and of becoming so clogged as to prevent the fluid from rising in them: they must then be trimmed, but this is seldomer necessary with alcohol and fine oils than with the coarser oils. Lamps are also improved by adding a chimney to them: it must admit the free access of air to the flame, and then it increases the current, confines the heat, and steadies the flame. The intensity of the temperature of flame may be increased astonishingly, by forcing a small current of hot air through it as by the blow-pipe. Wood, turf, coal, charcoal, and coke, solid combustibles, are burnt in grates and furnaces. Wood has the advantage of kindling readily, but affords a very unsteady temperature, is inconvenient from its flame, smoke, and soot, and requires much attention. The heavy and dense woods give the greatest heat, burn longest, and leave a dense charcoal. Dry turf gives a steady heat, and does not require so much attention as wood; but it consumes fast, its smoke is copious and penetrating, and the empyreumatic smell which it imparts to every thing it comes in contact with, adheres with great obstinacy.

The heavy turf of marshes is preferable to the light, superficial turf. Coal is the fuel most commonly used in this country: its heat is considerable, and sufficiently permanent, but it produces much flame and smoke. Charcoal, especially of the dense woods, is a very convenient and excellent fuel: it burns without flame or smoke, and gives a strong, uniform, and permanent heat, which may be easily regulated, especially when it is not in too large pieces, and is a little damp; but it is costly, and burns quickly. Coke, or charred coal, possesses similar properties to charcoal; it is less easily kindled, but is capable of producing a higher temperature, and burns more slowly.

When an open grate is used for chemical purposes, it should be provided with cranes, to support the vessels operated in, that they may not be overturned by the burning away of the fuel.

Furnaces. In all these, the principal objects are, to produce a sufficient degree of heat, with little consumption of fuel, and to be able to regulate the degree of heat. An unnecessary expenditure of fuel is prevented by forming the sides of the furnace of very imperfect conductors of caloric, and by constructing it so, that the subject operated on may be exposed to the full action of the fire. The degree of heat is regulated by the quantity of air which comes in contact with the burning fuel. The quantity of air is in the compound ratio of the size of the aperture through which it enters, and its velocity. The velocity is increased by mechanical means, as by bellows, or by increasing the height and width of the chimney. The size and form of furnaces, and the materials of which they are constructed, are various, according to the purposes for which they are intended.

The essential parts of a furnace are, a body for the fuel to burn in; a grate for it to burn upon; an ash-pit to admit air, and receive the ashes; a chimney for carrying off the smoke and vapours.

. The ash-pit should be perfectly close, and furnished with a door and register-plate, to regulate the quantity of air admitted. The bars of the grate should be triangular, and placed with an angle pointed downwards, and not above half an inch distant. The grate should be fixed on the outside of the body. The body may be cylindrical or elliptical, and it must have apertures for introducing the fuel and the subjects of the operation, and for conveying away the smoke and vapours. When the combustion is supported by the current of air naturally excited by the burning of the fuel, it is called a wind-furnace; when it is accelerated by increasing the velocity of the current by bellows, it forms a blast-furnace; and when the body of the furnace is covered with a dome, which terminates in the chimney, it constitutes a reverberatory furnace.

Furnaces are either fixed, and built of fire-brick, or portable, and fabricated of plate-iron. When of iron, they must be lined with some badly conducting and refractory substance, both to prevent the dissipation of heat, and to defend the iron against the action of the fire. A mixture of scales of iron and powdered tiles worked up with blood, hair, and clay, is much recommended; and Professor Hagen says, that it is less apt to split and crack when exposed at once to a violent heat, than when dried gradually, according to the common directions. Dr. Black employed two different coatings. Next to the iron he applied a composition of three parts by weight of charcoal, and one of fine clay. These are first mixed in the state of fine powder, and then worked up with as much water as will permit the mass to be formed into balls, which are applied to the sides of the furnace, and beat very firm and compact, with the face of a broad hammer, to the thickness of about one inch and a half in general, but so as to give an elliptical form to the cavity. Over this, another lute, composed of six or seven parts of sand, and one of clay, is to be applied in the same manner, to the thickness of about half an inch. These lutes must be allowed to become perfectly dry before the furnace is heated, which should at first be done gradually. They may also be lined with fire bricks of a proper form, accurately fitted and well cemented together before the top plate is screwed on.

The general fault of furnaces is that they admit too much air, which prevents us from regulating the temperature. It either becomes too violent and unmanageable, or when more cold air is admitted than what is necessary for supporting the combustion, it carries off heat, and prevents us from raising the temperature as high as we otherwise would. The superior merit of Dr. Black's furnace consists in the facility with which the admission of air is regulated;

and every attempt hitherto made to improve it, by increasing the number of its apertures, have in reality injured it.

Heat may be applied to vessels employed in chemical operations, directly, as in the open fire and reverberatory furnace: or through the medium of sand; the sand-bath: of water; the water-bath: of steam; the vapour-bath: of air; as in the muffle.

Changes produced by chemical processes. These consists chiefly in a new mode of aggregation, combination, and decomposition.

The form of *aggregation* may be altered by fusion, vaporization, condensation, congelation, and coagulation.

Fusion is the conversion of a solid into a liquid by the sole agency of caloric. Substances differ very much in the degrees of their fusibility; some, as water and mercury, existing as fluids in the ordinary temperatures of the atmosphere; while others, as the pure earths, cannot be melted by any heat we can produce.

Liquefaction is commonly employed to express the melting of substances, as tallow, wax, resin, &c. which pass through intermediate states of softness before they become fluid. Fusion is the melting of substances which pass immediately from the solid to the fluid state, as the salts and metals, except iron and platinum.

When, in consequence of fusion, the substances operated on acquire a greater or less degree of transparency, a dense uniform texture, and great brittleness, and exhibit a conchoidal fracture, with a specular surface, and the edges of the fragments very sharp, it is termed vitrification.

In general, simple substances are less fusible than compounds; for example, the simple earths cannot be melted singly, but when mixed are easily fused. The additions which are sometimes made to refractory substances, to promote their fusion, are termed fluxes: which fluxes are generally saline bodies.

Thus, the alkalies potash and soda promote powerfully the fusion of silicious stones; but they are only used for accurate experiments. The white flux is a mixture of a little potash with carbonate of potash, and is prepared by deflagrating together equal parts of nitrate of potash and super-tartrate of potash. When an oxide is at the same time to be reduced, the black flux is preferred, which is produced by the deflagration of two parts of super-tartrate of potash, and one of nitrate of potash. It differs from the former only in containing a little charcoal. Soap promotes fusion by being converted by the fire into carbonate of soda and charcoal.

Aluminous stones have their fusion greatly promoted by the addition of sub-borate of soda.

Muriate of soda, the mixed phosphate of soda and ammonia, and other salts, are also occasionally employed for the same purpose.

An open fire is sufficient to melt some substances, others require the heat of a furnace.

The vessels in which fusion is performed, must resist the heat necessary for the operation. In some instances an iron or copper ladle or pot may be used, but most commonly crucibles are employed. These are of various sizes. The large crucibles are generally conical, with a small spout for the convenience of pouring out; the small ones are truncated triangular pyramids, and are commonly sold in nests. The Hessian crucibles are composed of clay and sand, and when good, will support an intense heat for many hours, without softening or melting; but they are disposed to crack when suddenly heated or cooled. This inconvenience may be on many occasions avoided, by using a double crucible, and filling up the interstice with sand, or by covering the crucible with a lute of clay and sand, by which means the heat is transmitted more gradually and equally. Those which ring clearly when struck, and are of an uniform thickness, and have a reddish brown colour, without black spots, are reckoned the best. Wedgewood's crucibles are made of clay mixed with baked clay finely pounded, and are in every respect superior to the Hessian, but they are very expensive. The black lead crucibles, formed of clay and plumbago, are very durable, resist sudden changes of temperature, and may be repeatedly used, but they are destroyed when saline substances are melted in them, and suffer combustion when exposed red hot to a current of air.

When placed in a furnace, crucibles should never be set up on the bars of the grate, but always upon a support. Dr. Kennedy found the hottest part of a furnace to be about an inch above the grate. They may be covered, to prevent the fuel or ashes from falling into them, with a lid of the same materials, or with another crucible inverted over them. When the fusion is completed, the substance may be either permitted to cool in the crucible, or may

be poured into a heated mould anointed with tallow, never with oil, or what is still better, covered with a thin coating of chalk, which is applied by laying it over with a mixture of chalk diffused in water, and then evaporating the water completely by heat. To prevent the crucible from being broken by cooling too rapidly, it is to be either replaced in the furnace, to cool gradually with it, or covered with some vessel to prevent its being exposed immediately to the air.

Fusion is performed with the intention of weakening the attraction of aggregation; or of separating substances of different degrees of fusibility from each other.

Vaporization is the conversion of a solid or fluid into vapour by the agency of caloric. Although vaporability be merely a relative term, substances are said to be permanently elastic, volatile or fixed. The permanently elastic fluids or gases are those which cannot be condensed into a fluid or solid form by any abstraction of caloric we are capable of producing. Fixed substances, on the contrary, are those which cannot be converted into vapour by great increase of temperature. The pressure of the atmosphere has very considerable effect in varying the degree at which substances are converted into vapour. Some solids, unless subjected to very great pressure, are at once converted into vapour, although most of them pass through the intermediate state of fluidity.

Vaporization is employed to separate substances differing in volatility; and to promote chemical action, by disaggregating them.

When employed with either of these views, no regard is paid to the substances volatilized, whether from solids, as in ustulation and charring; or from fluids, as in evaporation; or whether the substances vaporized are condensed in proper vessels; for example, in a liquid form, as in distillation; or in a solid form, as in sublimation. Or whether the substances vaporized are permanently elastic, and are collected in their gaseous form, in a pneumatic apparatus.

Ustulation is almost entirely a metallurgic operation, and is employed to expel the sulphur and arsenic contained in some metallic ores. It is performed on small quantities in tests placed within a muffle. Tests are shallow vessels made of bone ashes or baked clay. Muffles are vessels of baked clay, of a semi-cylindrical form, the flat side forming the floor, and the arched portion the roof and sides. The end and sides are perforated with holes for the free transmission of air, and the open extremity is placed at the door of the furnace, for the inspection and manipulation of the process. The reverberatory furnace is commonly employed for roasting, and the heat is at first very gentle, and slowly raised to redness. It is accelerated by exposing as large a surface of the substance to be roasted as possible, and by stirring it frequently, so as to prevent any agglutination, and to bring every part in succession to the surface.

Charring may be performed on any of the compound oxides, by subjecting them to a degree of heat sufficient to expel all their hydrogen, nitrogen, and superabundant oxygen, while the carbon, being a fixed principle, remains behind in the state of charcoal. The temperature necessary for the operation may be produced either by the combustion of other substances, or by the partial combustion of the substance to be charred. In the former case, the operation may be performed in any vessel which excludes the access of air, while it permits the escape of the vapours formed. In the latter, the access of air must be regulated in such a manner, that it may be suppressed whenever the combustion has reached the requisite degree; for if continued to be admitted, the charcoal itself would be dissipated in the form of carbonic acid gas, and nothing would remain but the alkaline and earthy matter, which these substances always contain. When combustion is carried this length, the process is termed incineration. The vapours which arise in the operation of charring, are sometimes condensed, as in the manufacture of tar.

Evaporation is the conversion of a fluid into vapour, by its combination with caloric. In this process, the atmosphere is not a necessary agent, but rather a hindrance, by its pressure. This forms a criterion between chemical evaporation and spontaneous evaporation, which is merely the solution of a fluid in air. It is performed in open, shallow, or hemispherical vessels of silver, tinned copper or iron, earthenware or glass. The necessary caloric may be furnished by means of an open fire, a lamp, or a furnace, either immediately, or with the intervention of sand, water, or vapour. The degree of heat must be regulated by the nature of the substance operated on. In general, it should not be greater than what is absolutely necessary.

Evaporation may be partial; producing

from saline fluids, concentration; and from viscid fluids, inspissation; or it may be total and produce exsiccation. Concentration is employed to lessen the quantity of diluting fluids, which is called dephlegmation; or as a preliminary step to crystallization. Inspissation is almost confined to animal and vegetable substances; and as these are apt to be partially decomposed by heat, or to become empyreumatic, it should always be performed, especially towards the end of the process, in a water or vapour bath. Exsiccation is here taken in a very limited sense; for the term is also with propriety used to express the drying of vegetables by a gentle heat, the efflorescence of salts, and the abstraction of moisture from mixtures of insoluble powders with water, by means of chalk-stones, or powdered chalk pressed into a smooth mass. At present, we limit its meaning to the total expulsion of moisture from any body by means of caloric. The exsiccation of compound oxides should always be performed in the water bath. Salts are deprived of their water of crystallization by exposing them to the action of heat in a glass vessel or iron ladle. Sometimes they first dissolve in their water of crystallization, or undergo what is called the watery fusion, and are afterwards converted into a dry mass by its total expulsion; as in the calcination of borax or burning of alum. When exsiccation is attended with a crackling noise, and splitting of the salt, as in muriate of soda, it is termed decrepitation, and is performed by throwing into a heated iron vessel, small quantities of the salt at a time, covering it up, and waiting until the decrepitation be over, before a fresh quantity is thrown in. Exsiccation is performed on saline bodies, to render them more acrid or pulverulent, or to prepare them for chemical operations. Animal and vegetable substances are exsiccated to give them a solid form, and to prevent their fermentation.

Condensation is the reverse of expansion, and is produced either by mechanical pressure forcing out the caloric in a sensible form, as water is squeezed out of a sponge, or, by the chemical abstraction of caloric, which is followed by an approximation of the particles of the substance. This latter kind alone is the object of our investigation at present. In this way we may be supposed to condense substances existing naturally as gases or vapours; or substances, naturally solid or fluid, converted into vapours by adventitious circumstances. The former instance is almost supposititious; for we are not able, by any diminution of temperature, to reduce the permanently elastic fluids, to a fluid or solid state. The latter instance is always preceded by vaporization, and comprehends those operations in which the substances vaporized are condensed in proper vessels.

When the product is a fluid, it is termed distillation; when solid, sublimation. Distillation is said to be performed, *viâ humidâ*, when fluids are the subjects of the operation. *Viâ siccâ*, when solids are subjected to the operation, and the fluid product arises from decomposition, and a new arrangement of the constituent principles. The objects of distillation are, to separate more volatile fluids from less volatile fluids or solids. To promote the union of different substances: and to generate new products by the action of fire.

In all distillations, the heat applied should not be greater than what is necessary for the formation of the vapour, and even to this degree it should be gradually raised. The vessels also in which the distillation is performed should never be filled above one-half, and sometimes not above one-fourth, lest the substance contained in them should boil over.

As distillation is a combination of evaporation and condensation, the apparatus consists of two principal parts: the vessels in which the vapours are formed; and those in which they are condensed. The vessels employed for both purposes are very various in their shapes, according to the manner in which the operation is conducted. The first difference depends on the direction of the vapour after its formation. It either descends, ascends, or passes off by the side, constituting a distillation *per descensum*, *per ascensum*, or *per latus*.

In the distillation *per descensum*, a perforated plate of tinned iron, or other materials, is fixed within any convenient vessel, so as to leave a space beneath it. On this the subject of the operation is laid, and over it is placed another plate, accurately closing the mouth of the vessel, and sufficiently strong to support the fuel: thus the heat is applied from above, and the vapour is forced to descend into the inferior cavity, where it is condensed. In this way the oil of cloves is prepared, and on the same principles tar is manufactured, and mercury and zinc are separated from their ores.

In the distillation *per ascensum*, the vapour is allowed to arise to some height,

and then is conveyed away to be condensed. The vessel most commonly employed for this purpose is the common copper still, which consists of a body for containing the materials, and a head into which the vapour ascends. From the middle of the head a tube rises for a short way, and is then reflected downwards, through which the steam passes to be condensed. Another kind of head, rising to a great height before it is reflected, is sometimes used for separating fluids, which differ little in volatility, as it was supposed that the less volatile vapours would be condensed and fall back into the still, while only the more volatile vapours would arise to the top, so as to pass to the refrigeratory. The same object may be more conveniently attained by managing the fire with caution and address. The greater the surface exposed, and the less the height the vapours have to ascend, the more rapidly does the distillation proceed; and so well are these principles understood by the Scotch distillers, that they do not take more than three minutes to discharge a still containing gallons of fluid.

The condensing apparatus used with the common still is very simple. The tube in which the head terminates is inserted into the upper end of a pipe, which is kept cool by passing through a vessel filled with water, called the refrigeratory. This pipe is commonly made of a serpentine form; but as this renders it difficult to be cleaned, Dr. Black recommends a sigmoid pipe. The refrigeratory may be furnished with a stop-cock, that when the water it contains becomes too hot, and does not condense all the vapour produced, it may be changed for cold water. From the lower end of the pipe, the product of the distillation drops into the vessel destined to receive it; and we may observe, that when any vapour issues along with it, we should either diminish the power of the fire, or change the water in the refrigeratory. There was a process of this kind, called circulation. It consisted in arranging the apparatus, so that the vapours were no sooner condensed into a fluid form, than this fluid returned back into the distilling vessels, to be again vaporised; and was effected by distilling in a glass vessel, with so long a neck that the vapours were condensed before they escaped at the upper extremity, or by inverting one matrass within another. When corrosive substances are distilled in this way, the cucurbit and alembic are used; but these substances are more conveniently distilled *per latus*.

The distillation *per latus* is performed in a retort, or pear-shaped vessel, having the neck bent to one side. The body of a good retort is well rounded, uniform in its appearance, and of an equal thickness, and the neck is sufficiently bent to allow the vapours, when condensed, to run freely away, but not so much as to render the application of the receiver inconvenient, or to bring it too near the furnace. The passage from the body into the neck must be perfectly free and sufficiently wide, otherwise the vapours produced in the retort only circulate in its body without passing over into the receiver. For introducing liquors into the retort without soiling its neck, which would injure the product, a bent funnel is necessary. It must be sufficiently long to introduce the liquor directly into the body of the retort; and in withdrawing it, we must carefully keep it applied to the upper part of the retort, that the drop hanging from it may not touch the inside of the neck. In some cases, where a mixture of different substances is to be distilled, it is convenient and necessary to have the whole apparatus properly adjusted before the mixture is made, and we must therefore employ a tubulated retort, or a retort furnished with an aperture, accurately closed with a ground stopper. This tubulature should be placed on the upper convex part of the retort before it bends to form the neck, so that a fluid poured through it may fall directly into the body without soiling the neck.

Retorts are made of various materials. Flint-glass is commonly used when the heat is not so great as to melt it. For distillations which require excessive degrees of heat, retorts of earthenware, or coated glass retorts are employed. Quicksilver is distilled in iron retorts.

The simplest condensing apparatus used with the retort, is the common glass receiver; which is a vessel of a conical or globular form, having a neck sufficiently wide to admit of the neck of the retort being introduced within it. To prevent the loss and dissipation of the vapours to be condensed, the retort and receiver may be accurately ground to each other, or secured by some proper lute. To prevent the receiver from being heated by the caloric evolved during the condensation of vapours in it, we must employ some means to keep it cool. It is either immersed in cold water, or covered with snow, or pounded ice, or a constant evaporation is supported from its surface, by covering it with a cloth, which

is kept moist by means of the descent of water, from a vessel placed above it, through minute syphons or spongy worsted threads. But as, during the process of distillation, permanently elastic fluids are often produced, which would endanger the breaking of the vessels, these are permitted to escape either through a tubulature, or hole, in the side of the receiver, or rather through a hole made in the luting. Receivers having a spot issuing from their side, are used when we wish to keep separate the products obtained at different periods of any distillation. For condensing very volatile vapours, a series of receivers, communicating with each other, termed adopters, were formerly used; but these are now entirely superseded by Woulfe's apparatus, which consists of a tubulated retort, adapted to a tubulated receiver. With the tubulature of the receiver, a three-necked bottle is connected by means of a bent tube, the further extremity of which is immersed, one or more inches, in some fluid contained in the bottle. A series of two or three similar bottles are connected with this first bottle in the same way. In the middle tubulature of each bottle a glass tube is fixed, having its lower extremity immersed about a quarter of an inch in the fluid. The height of the tube above the surface of the fluid must be greater than the sum of the columns of fluid standing over the further extremities of the connecting tubes, in all the bottles or vessels more remote from the retort. Tubes so adjusted are termed tubes of safety, for they prevent that reflux of fluid from the more remote into the nearer bottles, and into the receiver itself, which would otherwise inevitably happen on any condensation of vapour taking place in the retort, receiver, or nearer bottles. Different contrivances for the same purpose have been described by Messrs. Welter and Burkitt; and a very ingenious mode of connecting the vessels without lute has been invented by Citizen Girard, but they would not be easily understood without plates. The further tubulature of the last bottle is commonly connected with a pneumatic apparatus, by means of a bent tube. When the whole is properly adjusted, air blown into the retort should pass through the receiver, rise in bubbles through the fluids contained in each of the bottles, and at last escape by the bent tube. In the receiver, these products of distillation are collected which are condensable by cold alone. The first bottle is commonly filled with water, and the others with alkaline solutions, or other active fluids; and as the permanently elastic fluids produced are successively subjected to the action of all these, only those gases will escape by the bent tube which are not absorbable by any of them.

In separating permanently elastic fluids or gases from the substances in which they are found, we are compelled to employ a distinct pneumatic apparatus; and the gas may then be received either into vessels absolutely empty; or, filled with some fluid, on which it exerts no action.

The first mode of collecting gases may be practised by means of a bladder, moistened sufficiently to make it perfectly pliable, and then compressed so as to press out every particle of air from its cavity. In this state it may be easily filled with any gas. An oiled silk bag will answer the same purpose, and is more convenient in some respects, as it may be made of any size or form. Glass or metallic vessels, such as balloons, may also be emptied for the purpose of receiving gases, by fitting them with a stop-cock, and exhausting the air from them by means of an air-pump.

But the second mode of collecting gases is the most convenient and common. In which case the vessels may be filled either with a fluid lighter, or heavier, than the gas to be received into it.

The former method is seldom employed; but if we conduct a stream of any gas heavier than atmospheric air, such as carbonic acid gas, muriatic acid gas, &c. to the bottom of any vessel, it will gradually displace the air, and fill the vessel. On the contrary, a gas lighter than atmospheric air, such as hydrogen, may be collected in an inverted vessel by conducting a stream of it to the top. But gases are most commonly collected by conducting the stream of gas into an inverted glass-jar, or any other vessel filled with water or mercury. The gas ascends to the upper part of the vessel, and displaces the fluid. In this way gas may be kept a very long time, provided a small quantity of the fluid be left in the vessels, which prevents both the escape of the gas, and the admission of atmospheric air.

The vessels may be made of various shapes; but those most commonly employed are cylindrical. They may be either open only at one extremity, or furnished at the other with a stop-cock. The manner of filling them with fluid, is to immerse them completely in it, with the open extremity directed a little upwards, so that the whole

air may escape from them, and then inverting them with their mouths downwards. For filling them with convenience, a trough or cistern is commonly used. This should either be hollowed out of a solid block of wood or marble; or, if it be constructed of wood simply, be well painted or lined with lead or tinned copper. Its size may vary very much; but it must contain a sufficient depth of fluid to cover the largest transverse diameter of the vessels to be filled in it. At one end or side, there should be a shelf for holding the vessels after they are filled. This shelf should be placed about an inch and a half below the surface of the fluid, and should be perforated with several holes, forming the apices of corresponding conical excavations on the lower side, through which, as through inverted funnels, gaseous fluids may be more easily introduced into the vessels placed over them. In general the vessels used with a mercurial apparatus should be stronger and smaller than those for a water-cistern, and we must have a variety of glass and elastic tubes for conveying the gases from the vessels in which they are formed to the funnels under the shelf.

The repeated distillation of any fluid is denominated rectification. When distillation renders the fluid stronger, or abstracts water from it, it is termed dephlegmation. When a fluid is distilled off from any substance, it is called abstraction; and if the product be redistilled from the same substance, or a fresh quantity of the same substance, it is denominated cohobation.

The difference between distillation and sublimation is only in the form of the product. When it is compact, it is termed a sublimate; when loose and spongy, it formerly had the appellation of flowers. Sublimation is sometimes performed in a crucible, and the vapours are condensed in a paper cone, or in another crucible inverted over it; sometimes in the lower part of a glass flask, cucurbit, or phial, and the condensation is effected in the upper part or capital, and sometimes in a retort with a very short and wide neck, to which a conical receiver is fitted. The heat is most commonly applied through the medium of a sand-bath; and the degree of heat, and the depth to which the vessel is inserted in it, are regulated by the nature of the sublimation.

Congelation is the reduction of a fluid to a solid form, in consequence of the abstraction of caloric. The means employed for abstracting the caloric, are the evaporation of volatile fluids, the solution of solids, and the contact of cold bodies.

Coagulation is the conversion of a fluid into a solid of greater or less consistence, merely in consequence of a new arrangement of its particles, as during the process there is no separation of caloric or any other substance. The means of producing coagulation are, increase of temperature, and the addition of certain substances, as acids and rennets.

Chemical Combination, is the intimate union of the particles of at least two heterogeneous bodies. It is the effect resulting from the exertion of the attraction of affinity, and is therefore subjected to all the laws of affinity.

To produce the chemical union of any two or more bodies, it is necessary, that they possess an affinity for each other; that their particles come into actual contact; that the strength of the affinity be greater than any counteracting causes which may be present.

The principal counteracting causes are, the attraction of aggregation; and affinities for other substances. The means to be employed for overcoming the action of other affinities, will be treated of under Decomposition. The attraction of aggregation is overcome by means of mechanical division; or the action of caloric.

Combination is facilitated by increasing the points of actual contact, by the means of mechanical agitation; by condensation and compression; and the processes employed for producing combination may be considered, with regard to the nature of the substances combined; and to the nature of the compound produced. Gases combine with gases, and dissolve fluids or solids, or are absorbed by them. Fluids are dissolved in gases, or absorb them; they combine with fluids, and dissolve solids, or are rendered solid by them. Solids are dissolved in fluids and in gases, or absorb gases, and solidify fluids.

The combination of gases with each other, in some instances, takes place when simply mixed together: thus nitrous and oxygen gases combine as soon as they come into contact; in other instances, it is necessary to elevate their temperature to a degree sufficient for their inflammation, either by means of the electric spark, or the contact of an ignited body, as in the combination of oxygen gas with hydrogen or nitrogen gas.

When gases combine with each other

there is always a considerable diminution of bulk, and not unfrequently they are condensed into a liquid or solid form. Hydrogen and oxygen gases form water; muriatic acid and ammonia gases form solid muriate of ammonia. But when the combination is effected by ignition, a violent expansion, which endangers the bursting of the vessels, previously takes place, in consequence of the increase of temperature.

Solution is the diminution of aggregation in any solid or fluid substance, in consequence of its entering into chemical combination. The substance, whether solid or fluid, whose aggregation is lessened, is termed the solvend; and the substance, by whose agency the solution is effected, is often called the menstruum or solvent. Solution is said to be performed *viâ humidâ*, when the natural form of the solvent is fluid; but when the agency of heat is necessary to give the solvent its fluid form, the solution is said to be performed *viâ siccâ*. The dissolving power of each menstruum is limited, and is determinate with regard to each solvend. The solubility of bodies is also limited and determinate with regard to each menstruum.

When any menstruum has dissolved the greatest possible quantity of any solvend, it is said to be saturated with it. But, in some cases, although saturated with one substance, it is still capable of dissolving others. Thus a saturated solution of muriate of soda will dissolve a certain quantity of nitrate of potash, and after that a portion of muriate of ammonia.

The dissolving power of solvents, and consequently the solubility of solvends, are generally increased by increase of temperature: and conversely, this power is diminished by diminution of temperature; so that, from a saturated solution, a separation of a portion of the solvend generally takes place on any reduction of temperature. This property becomes extremely useful in many chemical operations, especially in crystallization.

Particular terms have been applied to particular cases of solution.

The solution of a fluid in the atmosphere is termed spontaneous evaporation. It is promoted by exposing a large surface, by frequently renewing the air in contact with the surface, and by increase of temperature.

Some solids have so strong an affinity for water, that they attract it from the atmosphere in sufficient quantity to dissolve them; these are said to deliquesce; others, on the contrary, retain their water of crystallization with so weak a force, that the atmosphere attracts it from them, so that they crumble into powder. These are said to effloresce. Both operations are promoted by exposing large surfaces, and by a current of air; but the latter is facilitated by a warm, dry air, and the former by a cold, humid atmosphere.

Solution is also employed to separate substances, (for example, saline bodies), which are soluble in the menstruum, from others which are not. When our object is to obtain the soluble substance in a state of purity, the operation is termed lixiviation, and as small a quantity of the menstruum as is possible is used. When, however, it is employed to free an insoluble substance from soluble impurities, it is termed edulcoration, which is best performed by using a very large quantity of the menstruum.

Organic products being generally composed of heterogeneous substances, are only partially soluble in the different menstrua. To the solution of any of these substances, while the others remain undissolved, the term extraction is applied; and when, by evaporation, the substance extracted is reduced to a solid form, it is termed an extract, which is hard or soft, watery or spiritous, according to the degree of consistency it acquires, and the nature of the menstruum employed.

Infusion is employed to extract the virtues of aromatic and volatile substances, which would be dissipated by decoction, and destroyed by maceration, and to separate substances of easy solution from others which are less soluble. The process consists in pouring upon the substance to be infused, placed in a proper vessel, the menstruum, either hot or cold, according to the direction, covering it up, agitating it frequently, and, after a due time, straining or decanting off the liquor, which is now termed the infusion.

Maceration differs from infusion, in being continued for a longer time, and can only be employed for substances which do not easily ferment or spoil.

Digestion, on the other hand, differs from maceration only in the activity of the menstruum being promoted by a gentle degree of heat. It is commonly performed in a glass matrass, which should only be filled one-third, and covered with a piece of wet bladder, pierced with one or more small

boles, so that the evaporation of the menstruum may be prevented as much as possible, without risk of bursting the vessel. The vessel may be heated, either by means of the sun's rays, of a common fire, or of the sand-bath: and when the last is employed, the vessel should not be sunk deeper in the sand than the portion that is filled. Sometimes when the menstruum employed is valuable, a distilling apparatus used to prevent any waste of it. At other times, a blind capital is luted on the matrass, or a smaller matrass is inverted within a larger one; and as the vapour which arises is condensed in it, and runs back into the larger, the process in this form has got the name of circulation, upon which we have observed already.

Decoction is performed by subjecting the substances operated on to a degree of heat which is sufficient to convert the menstruum into vapour, and can only be employed with advantage for extracting principles which are not volatile, and from substances whose texture is so dense and compact as to resist the less active methods of solution. When the menstruum is valuable, that portion of it which is converted into vapour is generally saved by condensing it in a distilling apparatus.

Solutions in alcohol if coloured are termed tinctures, and in vinegar or wine, medicated vinegars or wines. The solution of metals in mercury is termed amalgamation. The combinations of other metals with each other form alloys.

Absorption is the condensation of a gas into a fluid or solid form, in consequence of its combination with a fluid or solid. It is facilitated by increase of surface and agitation; and the power of absorption in fluids is much increased by compression and diminution of temperature, although in every instance it be limited and determinate. Dr. Nooth invented an ingenious apparatus for combining gases with fluids, and Messrs. Schweppe, Paul, and Cuthbertson have very advantageously employed compression.

Fluids often become solid by entering into combination with solids, and this change is always accompanied by considerable increase of temperature, as in the slaking of lime.

Chemical Decomposition is the separation of the elementary parts of bodies which were chemically combined: and can only be effected by the agency of substances possessing a stronger affinity for one or more of the constituents of the compound, than these possess for each other.

Decomposition has acquired various appellations, according to the phenomena which accompany it.

Dissolution differs from solution in being accompanied by a decomposition, or change in the nature of the substance dissolved. Thus, we correctly say, a solution of lime in muriatic acid, and a dissolution of chalk in muriatic acid.

Sometimes a gas is separated during the action of bodies on each other. When this escapes with considerable violence and agitation of the fluid it is termed effervescence. The gas is very frequently allowed to escape into the atmosphere, but at other times is either collected in a pneumatic apparatus, or made to enter into some new combination. The vessels in which an effervescing mixture is made, should be high and sufficiently large, to prevent any loss of the materials from their running over, and in some cases the mixture must be made slowly and gradually.

Precipitation is the reverse of solution. It comprehends all those processes in which a solid is obtained by the decomposition of a solution. The substance separated is termed a precipitate, if it sink to the bottom of the fluid; or a cream, if it swim above it. Precipitation, like solution, is performed either *viâ humidâ*, or *viâ siccâ*; and is effected by lessening the quantity of the solvent by evaporation; by diminishing its powers, as by reduction of temperature, or dilution; or by the addition of some chemical agent, which, from its more powerful affinities, either combines with the solvent, and precipitates the solvend, or forms itself an insoluble compound with some constituent of the solution.

The objects of precipitation are, the separation of substances from solutions in which they are contained; the purification of solutions from precipitable impurities; or the formation of new combinations.

The two first means of precipitation have been already noticed. In performing it in the last manner we may observe the following rules:—The solution and precipitant must possess the requisite degree of purity. The solution should be perfectly saturated, to avoid unnecessary expenditure of the solvent or precipitant. The one is to be added slowly and gradually to the other. After each addition, they are to be thoroughly mixed by agitation. We must allow the

mixture to settle after we think that enough of the precipitant has been added, and try a little of the clear solution, by adding to it some of the precipitant; if any precipitation takes place, we have not added enough of the precipitant. This is necessary, not only to avoid loss, but in many instances the precipitant, if added in excess, re-dissolves or combines with the precipitate.

After the precipitation is completed, the precipitate is to be separated from the supernatant fluid by some of the means already noticed.

When the precipitate is the chief object of our process, and when it is not soluble in water, it is often advisable to dilute to a considerable degree both the solution and precipitant before performing the operation. When it is only difficultly soluble, we must content ourselves with washing the precipitate after it is separated by filtration. In some cases the separation of the precipitate is much assisted by a gentle heat.

Crystallization is a species of precipitation, in which the particles of the solvend, on separating from the solution, assume certain determinate forms. The conditions necessary for crystallization are, that the integrant particles have a tendency to arrange themselves in a determinate manner, when acted on by the atrraction of aggregation; that they be disaggregated, at least, so far as to possess sufficient mobility to assume their peculiar arrangement; and that the causes disaggregating them be slowly and gradually removed.

Notwithstanding the immense variety in the forms of crystals, M. Hauy has rendered it probable that there are only three forms of the integrant particles, the parallelopiped, the triangular prism, and the tetrahedron. But as these particles may unite in different ways, either by their faces or edges, they will compose crystals of various forms.

The primitive forms have been reduced to six, the parallelopiped, the regular tetrahedron, the octahedron with triangular faces, the six-sided prism, the dodecahedron terminated by rhombs, the dodecahedron with isoscles triangular faces.

Almost all sustances on crystallizing retain a portion of water combined with them, which is essential to their existence as crystals, and is therefore denominated water of crystallization. Its quantity varies very much in different crystallized substances.

The means by which the particles of bodies are disaggregated, so as to admit of crystallization, are solution, fusion, vaporization, or mechanical division and suspension in a fluid medium. The means by which the disaggregating causes are removed are evaporation, reduction of temperature, and rest.

When bodies are merely suspended in a state of extreme mechanical division, nothing but rest is necessary for their crystallization. When they are disaggregated by fusion or vaporization, the regularity of their crystals depends on the slowness with which their temperature is reduced; for if cooled too quickly, their particles have not time to arrange themselves, and are converted at once into a confused or unvaried solid mass. Thus glass, which when cooled quickly is so perfectly uniform in its appearance, when cooled slowly has a crystalline texture. But in order to obtain crystals by means of fusion, it is often necessary, after the substance has begun to crystallize, to remove the part which remains fluid; for otherwise it would fill up the interstices among the crystals first formed, and give the whole the appearance of one solid mass. Thus, after a crust has formed on the top of melted sulphur by pouring off the still fluid part, we obtain regular crystals.

The means by which bodies which have been disaggregated by solution are made to crystallise most regularly, vary according to the habitudes of the bodies with their solvents and caloric.

Some saline substances are much more soluble in hot than in cold water. Therefore a boiling saturated solution of any of these will deposit, on cooling, the excess of salt, which it is unable to dissolve when cold. These salts commonly contain much water of crystallization. Other salts are scarcely, if at all, more soluble in hot than in cold water; and, therefore, their solutions must be evaporated either by heat or spontaneously. These salts commonly contain little water of crystallization. The beauty and size of the crystals depend upon the purity of the solution, its quantity, and the mode of conducting the evaporation and cooling.

When the salt is not more soluble in hot than in cold water, by means of gentle evaporation, a succession of pellicles are formed on the top of the solution, which either are removed or permitted to sink to the bottom by their own weight; and the evaporation is continued until the crystallization be completed. But when the salt is capable of crystallizing on cooling, the evaporation is only continued until a drop of the

solution, placed upon some cold body, shews a disposition to crystallize, or at furthest only until the first appearance of a pellicle. The solution is then covered up, and set aside to cool, and the more slowly it cools the more regular are the crystals. The mother-water, or solution which remains after the crystals are formed, may be repeatedly treated in the same way as long as it is capable of furnishing any more salt.

When very large and beautiful crystals are wanted, they may be obtained by laying well-formed crystals in a saturated solution of the same salt, and turning them every day. In this way their size may be considerably increased, though not without limitation, for after a certain time they grow smaller instead of larger.

Crystallization is employed to obtain crystallizable substances in a state of purity; or to separate them from each other, by taking advantage of their different solubility at different temperatures.

General Analysis resulting from the Application of chemical Powers.

The simple elementary substances into which bodies are capable of being reduced, submitted to chemical action, are light, caloric, electricity, galvanism, magnetism, oxygen, hydrogen, nitrogen, carbon, sulphur, soda, potash, phosphorus, metals, and earths. Of these the first five have no appreciable gravity, which is evinced by all the rest. Of the latter, again, some are combustible, others incombustible; some oxygenizable, others destitute of all affinity for oxygen. But to enter minutely into these subjects would be to carry us beyond the limits of this article, and to infringe upon those that belong to chemistry as a general science, and to which, as also to the several articles above enumerated in the alphabetical order, we refer the reader for further information. So little progress, however, have we hitherto made in the general science of chemistry, that perhaps we are even now committing a double error in offering the above as a table of simple elementary substances. It is possible that not one of these substances is, strictly speaking, a simple element, or, in other words, totally uncompounded of rudiments that are more simple. We may also be in an error in conceiving every one of them to be a distinct substance from every other: we have many reasons, for example, for supposing that galvanism and electricity are the very same substance, only in different states of modification; and some philosophers have ventured to suspect that magnetism, or the magnetic power, is, in like manner, in unity with both. Neither soda nor potash, again, are scarcely any longer to be regarded as simple substances; we have many valuable experiments of Mr. Davy before us, by which they appear to have been completely decomposed; and there can be little doubt of the full confirmation of these experiments by subsequent trials of other chemists. And in this case it is possible that metallic substances will have to be as completely struck out of the list of simple elements as potash or soda. There are also several of the acids which are still admitted into the same catalogue; but whose pretensions are every day becoming still more doubtful, and of which, on this very account, we have taken no notice, though we shall have occasion to advert to them, and especially the muriatic acid, as we proceed. See LIGHT, CALORIC, ELECTRICITY, &c.

PART II.

PHARMACEUTICAL PREPARATIONS.

The classes into which these are divided have a considerable difference, as well in number as in arrangement, in our different collegiate Pharmacopœias. That of the London College in present use is become perfectly obsolete, both in order and nomenclature. To the nomenclature of the Edinburgh we have little to object, but canno' altogether approve of its order. Why the *Sulphurea* should lead the way, and be so far separated from the *Metallica*, with which they are so intimately connected by nature, we know not. We have reason to believe, that the forthcoming Pharmacopœia of the London College, will, in this, as well as in several other respects, evince a more systematic attention. In the mean time, while we give the general heads of both, we shall take the liberty of arranging them in the following manner:

1. Acida, acids.
2. Alkalina, alkalines.
3. Terrea, earths.
4. Sulphurea, sulphureous preparations.
5. Metallica, metalline preparations.
6. Olea fixata, fixed oils.
7. Aquæ distillatæ, distilled waters.
8. Olea volatilia, volatile oils.
9. Spiritus distillati, distilled spirits.
10. Decocta, decoctions.
11. Infusa, infusions.
12. Syrupi, syrups.

13. Mellita, medicated honeys.
14. Misturæ et emulsiones, mixtures and emulsions.
15. Aceta, medicated vinegars.
16. Tincturæ, tinctures.
17. Ætherea, ethereals and alcohols.
18. Vina, medicated wines.
19. Extracta, extracts.
20. Pulveres, powders.
21. Confectiones, confections.
22. Trochisci, troches.
23. Pilulæ, pills.
24. Cataplasmata, cataplasms.
25. Linimenta, liniments.
26. Unguenta, ointments.
27. Cerata, cerates.
28. Emplastra, plasters.

Class I. *Acida*. Acids.

The preparations under this name chiefly in use, and for which forms are given in the modern College Dispensatories, are

Sulphuric, Edin.
——— diluted, Edin. Lond.
Vitriolic diluted, Edin. Lond.
Nitric, Edin.
Nitrous, Lond. Dubl.
——— diluted, Lond. Dubl.
Muriatic, Edin. Lond. Dubl.
Acetous, Lond. Edin. acetum distil. Dubl.
Benzoic, Edin. Flores Benzoes, Lond.
Succinic, Edin. oleum succini, Lond.
Aqua aëris fixi, Dubl. water impregnated with fixed air.

Nitrous acid is frequently impure. Sulphuric acid is easily got rid of by re-distilling the nitrous acid from a small quantity of nitrate of potash. But its presence is not indicated when nitrous acid forms a precipitate with nitrate of baryte, as affirmed by almost all chemical authors; for nitrate of baryte was discovered by Mr. Hume to be insoluble in nitrous acid.

Muriatic acid is detected by the precipitate formed with nitrate of silver, and may be separated by dropping into the nitrous acid a solution of nitrate of silver, as long as it forms any precipitate, and drawing off the nitrous acid by distillation.

The general properties of nitrous acid have been already noticed. Mr. Davy has shewn that it is a compound of nitric acid and nitric oxide, and that by additional doses of the last constituent, its colour is successively changed, from yellow to orange, olive-green, and blue-green, and its specific gravity is diminished.

Vinegar may be distilled either in a common still or in a retort. The better kinds of wine-vinegar should be used. Indeed, with the best kind of vinegar, if the distillation be carried on to any great length, it is extremely difficult to avoid empyreuma. The best method of preventing this inconvenience is, if a retort be used, to place the sand but a little way up its sides, and when somewhat more than half the liquor is come over, to pour on the remainder a quantity of fresh vinegar equal to the liquor drawn off. This may be repeated three or four times; the vinegar supplied at each time being previously heated. The addition of cold liquor would not only prolong the operation, but also endanger the breaking of the retort.

Lowitz recommends the addition of half an ounce of recently burnt and powdered charcoal to each pound of vinegar in the still, as the best means of avoiding empyreuma.

If the common still be employed, it should likewise be occasionally supplied with fresh vinegar, in proportion as the acid runs off, and this continued until the process can be conveniently carried no further. The distilled acid must be rectified by a second distillation in a retort or glass alembic; for although the head and receiver be of glass or stone ware, the acid will contract a metallic taint from the pewter worm.

The residuum of this process is commonly thrown away as useless, although, if skilfully managed, it may be made to turn to good account, the strongest acid still remaining in it. Mixed with about three times its weight of fine dry sand, and committed to distillation in a retort, with a well-regulated fire, it yields an exceedingly strong empyreumatic acid. It is, nevertheless, without any rectification, better for some purposes, as being stronger, than the pure acid; particularly for making acetate of potash or soda: for then the empyreumatic oil is burnt out.

Distilled vinegar should be colourless and transparent; have a pungent smell, and purely acid taste, totally free from acrimony and empyreuma, and should be entirely volatile. It should not form a black precipitate on the addition of a solution of baryte, or of water saturated with sulphuretted hydrogen; or change its colour when super-saturated with ammonia. These circumstances show that it is adulterated with sulphuric acid, or contains lead, copper, or tin.

Distilled acetous acid, in its effects on the animal economy, does not differ from vinegar, and as it is less pleasant to the taste, it is only used for pharmaceutical preparations.

CLASS II. *Alkalina.* ALKALINES.

The following are the chief preparations under this head:

Carbonas potassæ, carbonate of potash, prepared kali, mild vegetable alkali, salt of tartar.

Potassa, pure kali, caustic vegetable alkali.

Potassa cum calce, lime with pure kali, mild caustic.

Aqua potassæ, Edin. aq. kali puri, Lond. water of potash, caustic ley.

Acetis potassæ, Edin. acetite of potash, acetated kali, Lond.

Sulphas potassæ, Edin. sulphate of potash, vitriolated tartar, vitriolated kali, Lond.

Sulphas potassæ c. sulphure, Edin. sulphate of potash with sulphur, sal polychrest, Lond.

Sulphuretum potassæ, Edin. sulphuret of potash, liver of sulphur.

Tartris potassæ, tartrite of potash, Edin. soluble tartar, tartarised kali, Lond.

Carbonas sodæ, carbonate of soda, Edin. prepared natron, Lond.

Phosphas sodæ, Edin. phosphate of soda.

Murias sodæ, muriate of soda, sea salt.

Sulphas sodæ, Edin. sulphate of soda, natron vitriolatum, Lond. Glauber's salt.

Tartris sodæ, Edin. tartrite of sodæ, natron tartarisatum, Lond. Rochelle salt.

Alcohol ammoniatum, Edin. ammoniated alcohol, spirit of ammonia, Lond.

Carbonas ammoniæ, Edin. carbonate of ammonia, prepared ammonia, Lond.

Aqua carbonatis ammoniæ, Edin. water of carbonate of ammonia.

Aqua acetitis ammoniæ, Edin. water of acetite of ammonia, spirit of mindereſus.

Hydro sulphuretum ammoniæ, hydro sulphuret of ammonia.

Liquor volutilis cornu cervi, sal et oleum, Lond. spirit oil, and salt of hartshorn.

CLASS III. *Terrena.* EARTHS, AND EARTHY SALTS.

The following are the preparations chiefly in use:

Murias barytæ, muriate of baryte, Edin.

Aqua calcis, lime water, Edin. Lond. Dubl.

Carbonas calcis præparatus, prepared chalk, Lond. carbonate of lime, Edin.

Phosphas calcis, Edin. phosphate of lime, burnt hartshorn, Lond.

Carbonas magnesiæ, Edin. magnesia alba, Lond. Dubl. carbonate of magnesia.

Phosphas calcis, Edin. magnesia usta, Lond. burnt or calcined magnesia.

Sulphas aluminæ exsiccatus, Edin. dried sulphate of alumine, burnt alum, Lond.

In the Dublin process for making magnesia there is a mutual decomposition of the two salts employed. The potash unites itself to the sulphuric acid, while the carbonic acid combines with the magnesia. The large quantity of water used is necessary for the solution of the sulphate of potash formed; and the boiling is indispensably requisite for the expulsion of a portion of the carbonic acid, which retains a part of the magnesia in solution. Sulphate of potash may be obtained from the liquor which passes through the filter, by evaporation. This is not pure, however, but mixed with undecomposed carbonate of potash; for one hundred parts of crystallized carbonate of potash are sufficient for the decomposition of one hundred and twenty-five parts of sulphate of magnesia; and as the carbonate of potash of commerce contains a larger proportion of alkali than the crystallized carbonate, a still less proportion should be used. From these quantities about forty-five parts of carbonate of magnesia are obtained.

The ablutions should be made with very pure water; for nicer purposes distilled water may be used, and soft water is in every case necessary. Hard water for this process is peculiarly inadmissible, as the principle in waters, giving the property called hardness, is generally a salt of lime, which decomposes the carbonate of magnesia, by compound affinity, giving rise to carbonate of lime, while the magnesia unites itself to the acid of the calcareous salt, by which the quantity of the carbonate is not only lessened, but is rendered impure by the admixture of carbonate of lime. Another source of impurity is the silica which the sub-carbonate of potash generally contains. It is most easily got rid of by exposing the alkaline solution to the air for several days before it is used. In proportion as it becomes saturated with carbonic acid, the silica is precipitated, and may be separated by filtration.

The carbonate of magnesia thus prepared is a very light, white, opaque substance,

without smell or taste, effervescing with acids. It is not, however, saturated with carbonic acid. By decomposing sulphate of magnesia by an alkaline carbonate, without the application of heat, carbonate of magnesia is gradually deposited in transparent, brilliant, hexagonal crystals, terminated by an oblique hexagonal plane, and soluble in about four hundred and eighty times its weight of water. The crystallized carbonate of magnesia consists of fifty acid, twenty-five magnesia, and twenty-five water; the sub-carbonate consists of forty-eight acid, forty magnesia, and twelve water; and the carbonate of commerce of thirty-four acid, forty-five magnesia, and twenty-one water. It is decomposed by all the acids, potash, soda, baryte, lime, and strontian, the sulphate, phosphate, nitrate, and muriate of alumina, and the super-phosphate of lime.

CLASS IV. SULPHUREA.

The preparations under this head are few; we need only enumerate the two following:

Sulphur lotum, Lond. washed flowers of sulphur.

Sulphur præcipitatum, Lond. precipitated sulphur.

In preparing this last, instead of dissolving sulphuret of potash in water, we may gradually add sublimed sulphur to a boiling solution of potash, until it be saturated. When the sulphuretted potash is thrown into water, it is entirely dissolved, but not without decomposition, for it is converted into sulphate of potash, hydroguretted sulphuret of potash, and sulphuretted hydroguret of potash. The two last compounds are again decomposed on the addition of any acid. The acid combines with the potash, sulphuretted hydrogen flies off in the form of gas, while sulphur is precipitated. It is of little consequence what acid is employed to precipitate the sulphur. The London College order the sulphuric; while the Dublin College use nitrous acid, probably because the nitrate of potash formed is more easily washed away than sulphate of potash.

Precipitated sulphur does not differ from well-washed sublimed sulphur, except in being much dearer. Its paler colour is owing to its more minute division, or, according to Dr. Thomson, to the presence of a little water; but from either circumstance it derives no superiority to compensate for the disagreeableness of its preparation.

These are all the more simple preparations of sulphur in common use. There are various preparations into which sulphur enters as an ingredient; but such as constituting compounds of the general nature of metals, alkalies, oils, &c. will be found under those classes.

CLASS V. *Metallica*. METALLINE PREPARATIONS.

The metalline prepartions are very numerous, especially those of antimony and quicksilver.

Sulphuretum antimonii præparatum, Edin. prepared antimony.

Oxidum antim. cum sulphure per nitratem potassæ, Edin. crocus of antimony, Lond.

Oxidum antimonii, cum sulphure, vitrificatum, vitrified antimony, Lond. glass of antimony.

Sulphuretum antimonii præcipitatum, precipitated sulphuret, or sulphur of antimony, Lond.

Murias antimonii, Edin. muriated antimony, Lond. butter of antimony.

Oxidum antimonii cum phosphate calcis, Edin. pulvis antimonialis, Lond. antimonial powder.

Tartris antimonii, tartarised, or tartrite of antimony.

Vinum tartritis antimonii, Edin. tartar emetic, antimonial wine, Lond.

Nitras argenti, Edin. argentum nitratum, Lond. nitrate of silver, lunar caustic.

Ærugo præparata, Lond. Dub. prepared verdigrease, or carbonate of copper.

Solutio sulphatis cupri composita, Edin. styptic water.

Ammoniaretum cupri, Edin. ammoniacal copper.

Aqua cupri ammoniati, Lond. water of the same.

Ferri limatura purificata, Edin. purified iron filings.

Carbonas ferri, Edin. rubigo ferri, Lond. carbonate, or rust of iron.

Sulphas ferri, Edin. vitriolated iron, Lond. sulphate of iron.

Tinctura muriatis ferri, tincture of muriate of iron, Lond.

Murias ammoniæ et ferri, martial flowers, ammoniacal iron, Lond.

Tinctura ejusdem, tincture of the same.

Tartris ferri, tartrite of, or tartarised, iron, Lond.

Vinum ferri, Lond. wine of iron.

Hydrargyrus purificatus, Lond. purified quicksilver.

Acetis hydrargyri acetite, Edin. of quicksilver.

Murias hydrargyri, Edin. Lond. muriate of quicksilver, corrosive sublimate.

Submurias hydrargyri, Edin. calomel, Lond.

Submurias hydrargyri præcipitatus, Edin. mild muriated quicksilver, Lond.

Calx hydrargyri alba, Lond. white precipitate.

Hydrargyrus calcinatus, Dub. Lond. calcined quicksilver.

Oxydum hydrargyri rubrum, Edin. red precipitate.

Subsulphas hydrargyri flavus, Edin. vitriolated quicksilver, Lond.

Sulphuretum hydrargyri nigrum, Edin. æthiops mineral, turpeth mineral.

Hydrargyrum sulphuratum nibrum, Lon. Dub. factitious cinnabar.

Acetis plumbi, Edin. acetite of lead, sugar of lead.

Aqua lithargyri acetata, Lond. extract of lead.

Cerussa acetata, Lond. acetated ceruse.

Stanni pulvis, Lond. powder of tin.

Oxydum zinci, Edin. oxide of zinc, calcined zinc. Lond.

Carbonas zinci, Edin. impurus præparatus, prepared calamine.

Oxydum zinci impurum præparatum, Edin. prepared tutty.

Sulphas zinci, Edin. vitriolated zinc, Lond.

The antimonial powder of the London College is supposed to be nearly the same with the celebrated nostrum of Dr. James, the composition of which was ascertained by Dr. Pearson of London, to whom we are also indebted for the above formula.

By burning sulphuret of antimony and shavings of hartshorn in a white heat, the sulphur is entirely expelled, and the antimony is oxydized, while the gelatine of the hartshorn is destroyed, and nothing is left but phosphate of lime, combined with a little lime. Therefore the mass which results is a mixture of oxide of antimony and phosphate of lime, which corresponds, at least, as to the nature of the ingredients, with James's powder, which, by Dr. Pearson's analysis, was found to consist of 43 phosphate of lime, and 57 oxide of antimony. Another excellent chemist, M. Chenevix, has lately proposed a method of forming the same combination in the humid way, with the view of obtaining a preparation always similar in its composition and properties. He has led to this proposal by considering the uncertainty of the application, and the precarious nature of the agency of fire, by which means a variable portion of the oxide of antimony may be volatalised, and that which remains may be oxydized in various degrees.

M. Chenevix, therefore, proposes to prepare a substitute for James's powder by dissolving together equal weights of submuriate of antimony and of phosphate of lime in the smallest possible quantity of muriatic acid, and then pouring this solution gradually into water sufficiently alkalized with ammonia. For the reason mentioned in the preceding article, it is absolutely necessary that the muriatic solution be poured into the alkaline liquor. By an opposite mode of procedure, the precipitate would contain more antimony at first, and towards the end the phosphate of lime would be predominant, and the antimony would be partly in the state of a submuriate. The phosphate of lime is most conveniently obtained pure by dissolving calcined bone in muriatic acid, and by precipitating it by ammonia. If the ammonia be quite free from carbonic acid, no muriate of lime is decomposed. M. Chenevix also found that his precipitate is entirely soluble in every acid which can dissolve either phosphate of lime or oxide of antimony separately, and that about 0.28 of James's powder, and at an average 0.44 of the pulvis antimonialis of the London Pharmacopœia resist the action of every acid.

Class VI. *Olea Fixata.* Fixed Oils.

These oils are improperly denominated expressed, which is their usual characteristic name, as in some instances they are obtained without expression, and in other instances expression is employed to obtain volatile oils. The Edinburgh college have therefore distinguished these different classes of oils by the terms fixed and volatile, which accurately characterize them.

Fixed oil is formed in no other part of vegetables than in their seeds. Sometimes, although very rarely, it is contained in the parenchyma of the fruit. Of this, the best known example is the olive. But it is most commonly found in the seeds of dicotyledonous vegetables, sometimes also in the fruit of monocotyledonous plants, as the cocos butyracea. It has various degrees of consistency, from the tallow of the croton sebiferum of China, and the butter

of the butter-tree of Africa, to the fluidity of olive oil.

Fixed oils are either, 1. Fat, easily congealed, and not inflammable by nitric acid, oil of olives, almonds, rapeseed, and ben. 2. Drying, not congealable, inflammable by nitric acid, oil of linseed, nut, and poppy. 3. Concrete oils, palm oil, &c.

Fixed oil is separated from fruits and seeds which contain it, either by expression or decoction. Heat, by rendering the oil more limpid, increases very much the quantity obtained by expression; but as it renders it less bland, and more apt to become rancid, heat is not used in the preparation of oils which are to be employed in medicine. When obtained by expression, oils often contain a mixture of mucilage, starch, and colouring matter; but part of these separate in course of time, and fall to the bottom. When oils become rancid, they are no longer fit for internal use, but are then said to effect the killing of quicksilver, as it is called, more quickly. Decoction is principally used for the extraction of the viscid and consistent oils, which are melted out by the heat of the boiling water, and rise to its surface.

Those who prepare large quantities of the oil of almonds, blanch them, by steeping them in very hot water, which causes their epidermis to swell, and separate easily. After they peel them, they dry them in a stove, then grind them in a mill like a coffee mill, and lastly, express the oil from the paste inclosed in a hempen bag. By blanching the almonds, the paste which remains within the bag is sold with greater advantage to the perfumers, and the oil obtained is perfectly colourless. But the heat employed disposes the oil to become rancid, and the colour the oil acquires from the epidermis does not injure its qualities. For pharmaceutical use, therefore, the oil should not be expressed from blanched almonds, but merely rubbed in a piece of coarse linen, to separate the brown powder adhering to the epidermis, as much as possible. Sixteen ounces of sweet almonds commonly give five ounces and a half of oil. Bitter almonds afford the same proportions, but the oil has a pleasant bitter taste.

In this manner are to be expressed,

Oleum amygdalæ, almond oil, from the kernel.

Oleum lini, linseed oil, from the bruised seeds.

Oleum ricini, castor oil, from the seeds previously decorticated.

Oleum sinapeos, oil of mustard, from the bruised seeds.

Class VII. *Aquæ Distillatæ*. Distilled Waters.

Substances which differ in volatility, may be separated from each other by applying a degree of heat capable of converting the most volatile into vapour, and by again condensing this vapour in a proper apparatus. Water is converted into vapour at 212°, and may be separated by distillation from the earthy and saline matters which it always contains in a natural state. But, it is evident, that if any substances which are as volatile as water, be exposed to the same degree of heat, either by immersing them in boiling water, or exposing them to the action of its steam, they will rise with it in distillation. In this way the camphor and volatile oils of vegetable substances are separated from the more fixed principles; and as water is capable of dissolving a certain quantity of these volatile substances, it may be impregnated with a great variety of flavours by distilling it from different aromatic substances. If the subject of our distillation contain more volatile oil than the water employed is capable of dissolving, it will render the water milky, and afterwards separate from it. It is in this way that essential oils are obtained.

Essential oils are obtained only from odoriferous substances; but not equally from all of this class, nor in quantity proportional to their degree of odour. Some, which, if we were to reason from analogy, should seem very well fitted for this process, yield extremely little oil, and others none at all. Roses and chamomile flowers, whose strong and lasting smell promises abundance, are found to contain but a small quantity of oil; the violet and jessamine flower, which perfume the air with their odour, lose their smell upon the gentlest coction, and do not afford any oil, on being distilled, unless immense quantities are submitted to the operation at once; while savin, whose disagreeable scent extends to no great distance, gives out the largest proportion of oil of almost any vegetable known.

Nor are the same plants equally fit for this operation, when produced in different soils or seasons, or at different times of their growth. Some yield more oil, if gathered when the flowers begin to fall off, than at any other time. Of this we have examples in lavendar and rue; others, as sage, afford the largest quantity when young, before

they have sent forth any flowers; and others, as thyme, when the flowers have just appeared. All fragrant herbs yield a larger proportion of oil, when produced in dry soils and in warm summers, than in opposite circumstances. On the other hand, some of the disagreeable strong-scented ones, as wormwood, are said to contain most oil in rainy seasons, and when growing in moist, rich grounds.

Several chemists have been of opinion, that herbs and flowers, moderately dried, yield a greater quantity of essential oil, than if they were distilled when fresh. It is, however, highly improbable, that the quantity of essential oil will be increased by drying; on the contrary, part of it must be dissipated and lost. But drying may sometimes be useful in other ways; either by diminishing the bulk of the subject to be distilled, or by causing it to part with its oil more easily.

The choice of proper instruments is of great consequence for the performance of this process to advantage. There are some oils which pass freely over the swan-neck of the head of the common still: others, less volatile, cannot easily be made to rise so high. For obtaining these last, we would recommend a large low head, having a rim or hollow canal round it: in this canal, the oil is detained in its first ascent, and thence conveyed at once into the receiver, the advantages of which are sufficiently obvious.

With regard to the proportion of water to be employed; if whole plants, moderately dried, are used, or the shavings of woods, as much of either may be put into the vessel, as, lightly pressed, will occupy half its cavity; and as much water may be added as will fill two thirds of it. When fresh and juicy herbs are to be distilled, thrice their weight of water will be fully sufficient; but dry ones require a much larger quantity. In general, there should be so much water, that after all intended to be distilled has come over, there may be liquor enough left to prevent the matter from burning to the still. The water and ingredients, altogether, should never take up more than three fourths of the still; there should be liquor enough to prevent any danger of an empyreuma, but not so much as to be apt to boil over into the receiver.

The subject of distillation should be macerated in the water until it be perfectly penetrated by it. To promote this effect, woods should be thinly shaved across the grain, or sawn; roots cut transversely into thin slices, barks reduced into coarse powder, and seeds slightly bruised. Very compact and tenacious substances require the maceration to be continued a week or two, or longer; for those of a softer and looser texture, two or three days are sufficient; while some tender herbs and flowers not only stand in no need of maceration, but are even injured by it. The fermentation which was formerly prescribed in some instances, is always hurtful.

With regard to the fire, the operator ought to be expeditious in raising it at first, and to keep it up during the whole process, to such a degree only, that the oil may freely distil; otherwise the oil will be exposed to an unnecessary heat; a circumstance which ought as much as possible to be avoided. Fire communicates to all these oils a disagreeable impregnation, as is evident from their being much less grateful when newly distilled, than after they have stood for some time in a cool place: and the longer the heat is continued, the greater alteration it produces in them.

The greater number of oils require for their distillation the heat of water strongly boiling: but there are many also which rise with a heat considerably less; such as those of lemon and citron peel; of the flowers of lavender and rosemary, and of almost all the more odoriferous kinds of flowers. We have already observed, that these flowers have their fragrance much injured, or even destroyed, by beating or bruising them; it is impaired also by the immersion in water in the present process, and the more so in proportion to the continuance of the immersion and the heat; hence oils, distilled in the common manner, prove much less agreeable in smell than the subjects themselves. For the distillation of substances of this class, another method has been contrived; instead of being immersed in water, they are exposed only to its vapour. A proper quantity of water being put into the bottom of the still, the odoriferous herbs or flowers are laid lightly in a basket, of such a size that it may enter into the still, and rest against its sides just above the water. The head being then fitted on, and the water made to boil, the steam, percolating through the subject, imbibes the oil, without impairing its fragrance, and carries it over into the receiver. Oils thus obtained, possess the odour of the subject in an exquisite degree, and have nothing of the disagreeable scent perceivable in those

distilled by boiling them in water in the common manner.

Plants differ so much, according to the soil and season of which they are the produce, and likewise according to their own ages, that it is impossible to fix the quantity of water to be drawn from a certain weight of them to any invariable standard. The distillation may always be continued as long as the liquor runs well flavoured off the subject, but no longer.

In the distillation of essential oils, the water, as was observed in the foregoing section, imbibes always a part of the oil. The distilled liquors here treated of, are no other than water thus impregnated with the essential oil of the subject; whatever smell, taste, or virtue, is communicated to the water, or obtained in the form of watery liquor, being found in a concentrated state in the oil.

All those vegetables, therefore, which contain an essential oil, will give over some virtue to water by distillation: but the degree of the impregnation of the water, or the quantity of water which the plant is capable of saturating with its virtue, are by no means in proportion to the quantity of its oil. The oil saturates only the water that comes over at the same time with it: if there be more oil than is sufficient for this saturation, the surplus separates, and concretes in its proper form, not miscible with the water that arises afterwards. Some odoriferous flowers, whose oil is in so small quantity that scarcely any visible mark of it appears, unless fifty or an hundred pounds or more are distilled at once, give nevertheless as strong an impregnation to water as those plants which abound most with oil.

Many have been of opinion, that distilled waters may be more and more impregnated with the virtues of the subject, and their strength increased to any assigned degree, by cohobation, that is, by re-distilling them repeatedly from fresh parcels of the plant; experience, however, shews the contrary. A water, skilfully drawn in the first distillation, proves, on every repeated one, not stronger, but more disagreeable. Aqueous liquors are not capable of imbibing above a certain quantity of the volatile oil of vegetables; and this they may be made to take up by one, as well as by any number of distillations: the oftener the process is repeated, the ungrateful impression which they generally receive from the fire, even at the first time, becomes greater and greater.

Those plants which do not yield at first waters sufficiently strong, are not proper subjects for this process.

The mixture of water and oil which comes over, may either be separated immediately, by means of a separatory, or after it has been put into large narrow-necked bottles, and placed in a cool place, that the portion of oil which is not dissolved in the water, may rise to the top, or sink to the bottom, according to its specific gravity. It is then to be separated, either by a separatory, or by means of a small glass syringe; or by means of a filter of paper; or, lastly, by means of a woollen thread, one end of which is immersed in the oil, and the other lower end in a phial: the oil will thus pass over into the phial by capillary attraction, and the thread is to be squeezed dry.

Most distilled waters, when first prepared, have a somewhat unpleasant smell, which, however, they gradually lose: it is therefore advisable to keep them for some days after their preparation in vessels but slightly covered; and not to cork them up until they lose that smell.

That the waters may keep the better, about one-twentieth part of their weight of proof spirit may be added to each after they are distilled. I have been informed by a respectable apothecary, that if the simple distilled waters be rectified by distilling them a second time, they will keep for several years without the addition of any spirit, which always gives an unpleasant flavour, and is often objectionable for other reasons.

Distilled waters are employed chiefly as grateful diluents, as suitable vehicles for medicines of greater efficacy, or for rendering disgustful ones more acceptable to the palate and stomach: few are depended on, with any intention of consequence by themselves.

To the chapter on simple distilled waters, the London college have annexed the following remarks.

"We have ordered most of the waters to be distilled from the dried herbs, because fresh are not ready at all times of the year. Whenever the fresh are used, the weights are to be increased. But, whether, the fresh or dried herbs be employed, the operator may vary the weight according to the season in which they have been produced and collected."

Herbs and seeds kept beyond the space of a year, become less proper for the distillation of waters.

To every gallon of these waters add five ounces, by measure, of proof spirit.

The Edinburgh college order half an ounce of proof spirit to every pound of the water, which is nearly the same.

But the Dublin college order five ounces of proof spirit to be added to each pound, which is probably a typographical error.

Water itself is ordered to be distilled, to give it greater purity; and the substances from which distilled waters are to be drawn, are as follow: the weight of each being sufficient for a gallon.

Two pounds of fresh orange-peel, Edin.
Aqua citri aurantii.

One pound of sweet fennel seeds bruised, Lond. Dubl.
Aqua fœniculi dulcis.

Six pounds of the recent petals of the damask rose,
Aqua rosæ centifoliæ, Edin.
Aqua rosæ, Lond. Dub.

Three pounds, Edin. one pound and a half, Lond. Dubl. of peppermint,
Aqua menthæ piperitæ, Edin.
Aqua menthæ piperitidis, Lond. Dub.

Three pounds, Edin. one pound and a half, Lond. Dubl. of pennyroyal, in flower,
Aqua menthæ pulegii, Edin.
Aqua pulegii, Lond. Dubl.

Two pounds of fresh lemon peel,
Aqua citri medicæ, Edin.

One pound and a half of spearmint,
Aqua menthæ sativæ, Dubl. Lond.

One pound of cinnamon, (macerated for a day) Lond. Dubl.
Aqua lauri cinnamoni, Edin.
Aqua cinnamoni, Lond. Dubl.

One pound of cassia,
Aqua lauri cassiæ, Edin.

One pound of bruised dill seeds,
Aqua anethi, Lond.

Half a pound of pimento, (macerated for a day), Lond.
Aqua myrti pimentæ, Edin.
Aqua pimento, Lond.

The virtues of all these waters are nearly alike; and the peculiarities of each will be easily understood by consulting the account given in the materia medica, of the substance from which they are prepared. Mr. Nicholson mentions, that as rose-water is exceedingly apt to spoil, the apothecaries generally prepare it in small quantities at a time from the leaves, preserved by packing them closely in cans with common salt. This we understand is not the practice in Edinburgh, and indeed cannot succeed with the petals of the damask rose, for they lose their smell by drying. The London apothecaries, therefore, probably use the red rose. The spoiling of some waters is owing to some mucilage carried over in the distillation; for, if rectified by a second distillation, they keep perfectly.

Class VIII. *Olea Volatilia.* Volatile Oils.

These are prepared nearly in the same manner as distilled waters, except that less water is to be added.

Seeds, and woody substances, are to be previously bruised, or rasped. The oil comes over with the water, and is afterwards to be separated from it, according as it may be lighter than the water, and swim upon its surface, or heavier, and sink to the bottom.

Besides, in preparing distilled waters and oils, it is to be observed, that the goodness of the subject, its texture, the season of the year, and similar causes, must give rise to so many differences, that no certain or general rule can be given to suit accurately each example. Hence, the following is the mode prescribed by the London College.

According to these directions are prepared the volatile, distilled, or essential, oils; or olea volatilia, Edin. distilla, Dub. vel essentialia, Lond.

Anise, pimpinellæ anisi, Edin. anisi, Lon. Dub.

Caraway, carui, Lond. Dub.

Fennel seeds, seminum fœniculi dulcis. Dub. from the seeds.

Juniper berries, juniperi communis, Edin. baccarum juniperi, Dub. juniperi baccæ. Lond. from the berries.

Pimento, myrti pimentæ, Edin. from the fruit.

Fennel flowers, florum fœniculi dulcis, Dub.

Rosemary, rorismarini officinalis, Edin. rorismarini, Lond. Dub.

Lavender, lavandulæ spicæ, Edin. lavendulæ. Lond.

Peppermint, menthæ piperitæ, Edin. menthæ piperitidis, Lond. Dub.

Spearmint, menthæ sativæ, Lond. Dub.

Pennyroyal, pulegii, Lond. Dub.

Origanum, origani, Lond. Dub.

Rue, rutæ, Dub.

Savine, juniperi sabinæ. Edin. sabinæ, Dub. from the flower, or herb in flower.

Sassafras, lauri sassafras, Edin. sassafras, Lond. from the root.

And, turpentine, pinus picea, from the resin.

The residuum, after the oil has been extracted, is the officinal resin (resina flava): and a rectified spirit is obtained by distilling the oil of turpentine with four times its weight of water.

The spirit of turpentine, as this essential oil has been styled, is frequently taken internally as a diuretic and sudorific; and it has sometimes a considerable effect when taken to the extent of a few drops only. It has, however, been given in much larger doses, especially when mixed with honey. Recourse has principally been had to such doses in cases of chronic rheumatism, particularly in those modifications of it which are termed sciatica and lumbago; but sometimes it induces bloody urine.

The water employed in the distillation of volatile oils always imbibes some portion of the oil; as is evident from the smell, taste, and colour, which it acquires. It cannot, however, retain above a certain quantity; and therefore, such as has been already used and almost saturated itself, may be advantageously employed, instead of common water, in a second, third, or any future, distillation of the same subject.

After the distillation of one oil, particular care should be had to clean the worm perfectly before it be employed in the distillation of a different substance. Some oils, those of wormwood and aniseeds for instance, adhere to it so tenaciously, as not to be melted out by heat, or washed off by water; the best way of removing these, is to run a little spirit of wine through it.

Volatile oils, after they are distilled, should be suffered to stand for some days, in vessels loosely covered with paper, till they have lost their disagreeable fiery odour, and become limpid; then put them up in small bottles, which are to be kept quite full, closely stopped, in a cool place. With these cautions, they will retain their virtues in perfection for many years.

Most of the oils mentioned above, are prepared by our chemists in Britain, and are easily procurable in a tolerable degree of perfection; but the oils from the more expensive spiceries, though still introduced among the preparations in the foreign pharmacopœias, are, when employed among us, usually imported from abroad.

These are frequently so much adulterated that it is not easy to meet with such as are at all fit for use. Nor are these adulterations easily discoverable. The grosser abuses, indeed, may be readily detected. Thus, if the oil be mixed with spirit of wine it will turn milky on the addition of water; if with expressed oils, rectified spirit will dissolve the volatile, and leave the other behind; if with oil of turpentine, on dipping a piece of paper in the mixture, and drying it with a gentle heat, the turpentine will be betrayed by its smell. But the more subtile artists have contrived other methods of sophistication, which elude all trials of this kind.

Some have looked upon the specific gravity of oils as a certain criterion of their genuineness. This, however, is not to be absolutely depended on; for the genuine oils, obtained from the same subjects, often differ in gravity as much as those drawn from different ones. Cinnamon and cloves, whose oils usually sink in water, yield, if slowly and warily distilled, oils of great fragrancy, which are nevertheless specifically lighter than the aqueous fluid employed in their distillation; whilst on the other hand, the last runnings of some of the lighter oils prove sometimes so ponderous as to sink in water.

As all volatile oils agree in the general properties of solubility in spirit of wine, indissolubility in water, miscibility with water by the intervention of certain intermedia, volatility in the heat of boiling water, &c. it is plain that they may be variously mixed with each other, or the dearer sophisticated with the cheaper, without any possibility of discovering the abuse by any trials of this kind. And, indeed, it would not be of much advantage to the purchaser, if he had infallible criteria of the genuineness of every individual oil. It is of as much importance that they be good, as that they be genuine; for genuine oils, from inattentive distillation, and long and careless keeping, are often weaker both in smell and taste than the common sophisticated ones.

The smell and taste seem to be the only certain tests of which the nature of the thing will admit. If a bark should have, in every respect, the appearance of good cinnamon, and should be proved indisputably to be the genuine bark of the cinnamon tree; yet if it want the cinnamon flavour, or has it but in a low degree, we reject it; and the case is the same with the oil. It is only from use and habit, or comparisons

with specimens of known quality, that we can judge of the goodness either of the drugs themselves, or of their oils.

Most of the volatile oils indeed are too hot and pungent to be tasted with safety; and the smell of the subject is so much concentrated in them, that a small variation in this respect is not easily distinguished; but we can readily dilute them to any assignable degree. A drop of the oil may be dissolved in spirit of wine, or received on a bit of sugar, and dissolved by that intermedium in water. The quantity of liquor which it thus impregnates with its flavour, or the degree of flavour which it communicates to a certain determinate quantity, will be the measure of the degree of goodness of the oil.

Medical use. Volatile oils, medicinally considered, agree in the general qualities of pungency and heat; in particular virtues they differ as much as the subjects from which they are obtained, the oil being the direct principle in which the virtues, or at least a considerable part of the virtues, of the several subjects reside. Thus the carminative virtue of the warm seeds, the diuretic of juniper berries, the emmenagogue of savin, the nervine of rosemary, the stomachic of mint, the antiscorbutic of scurvy-grass, the cordial of aromatics, &c. are supposed to be concentrated in their oils.

There is another remarkable difference in volatile oils, the foundation of which is less obvious, that of the degree of their pungency and heat. These are by no means in proportion, as might be expected, to those of the subject they were drawn from. The oil of cinnamon, for instance, is excessively pungent and fiery; in its undiluted state it is almost caustic; whereas cloves, a spice which in substance is far more pungent than the other, yields an oil which is far less so. This difference seems to depend partly upon the quantity of oil afforded, cinnamon yielding much less than cloves, and consequently having its active matter concentrated into a smaller volume; partly, upon a difference in the nature of the active parts themselves: for though volatile oils contain always the specific odour and flavour of their subjects, whether grateful or ungrateful, they do not always contain the whole pungency: this resides frequently in a more fixed matter, and does not rise with the oil. After the distillation of cloves, pepper, and some other spices, a part of their pungency is found to remain behind: a simple tincture of them in rectified spirit of wine is even more pungent than their pure essential oils.

The more grateful oils are frequently made use of for reconciling to the stomach medicines of themselves disgustful. It has been customary to employ them as correctors for the resinous purgatives; an use which they do not seem to be well adapted to. All the service they can here be of is to make the resin sit more easily at first on the stomach: far from abating the irritating quality upon which the violence of its operation depends, these pungent oils superadd a fresh stimulus.

Volatile oils are never given alone, on account of their extreme heat and pungency; which in some is so great, that a single drop let fall upon the tongue produces a gangrenous eschar. They are readily imbibed by pure dry sugar, and in this form may be conveniently exhibited. Ground with eight or ten times their weight of sugar they become soluble in aqueous liquors, and thus may be diluted to any assigned degree. Mucilages also render them miscible with water into an uniform milky liquor. They dissolve likewise in spirit of wine; the more fragrant in an equal weight, and almost all of them in less than four times their own quantity. These solutions may be either taken on sugar, or mixed with syrups, or the like. On mixing them with water the liquor grows milky, and the oil separates.

The more pungent oils are employed externally against paralytic complaints, numbness, pains, and aches, cold tumours, and in other cases where particular parts require to be heated or stimulated. The tooth-ach is sometimes relieved by a drop of these almost caustic oils, received on cotton, and cautiously introduced into the hollow tooth.

Among the volatile oils ought also to be enumerated the empyreumatic oils; for these also are volatile, but have a character peculiar to themselves. The simple volatile oils exist ready formed in the aromatic substances from which they are obtained, and are only separated from the fixed principles by the action of a heat not exceeding that of boiling water. The empyreumatic, on the contrary, are always formed by the action of a degree of heat considerably higher than that of boiling water, and are the product of decomposition, and a new arrangement of the elementary principles of substances, containing at least oxygen, hydrogen, and carbon. Their production is therefore always attended with the formation of other new products. In their chemical

properties they do not differ very remarkably from the volatile oils, and are principally distinguished from them by their unpleasant, pungent smell, and rough, bitterish taste. The following are the chief:

Oleum petrolei, oil of bitumen, or tar.

Oleum succini, oil of amber, which is afterwards rectified.

Oleum animale, animal oil, obtained from hartshorn, which also is rectified by being again distilled with water.

Class IX. *Spiritus Distillati.* Distilled Spirits.

The flavour and virtues of distilled waters are owing, as observed in the preceding chapter, to their being impregnated with a portion of the essential oil of the subject from which they are drawn. Alcohol, considered as a vehicle for these oils, has this advantage above water, that it keeps all the oil that rises with it perfectly dissolved into an uniform limpid liquor.

Nevertheless many substances, which, on being distilled with water, impart to it their virtues in great perfection; if treated in the same manner with alcohol, scarcely give over to it any smell or taste. The cause of this difference is, that alcohol is not susceptible of so great a degree of heat as water. It is obvious, therefore, that substances may be volatile enough to rise with the heat of boiling water, but not with that of boiling alcohol.

Thus if cinnamon, for instance, be committed to distillation with a mixture of alcohol and water, or with a pure proof spirit, which is no other than a mixture of about equal parts of the two; the alcohol will arise first clear, colourless, and transparent, and almost without any taste of the spice; but as soon as the more ponderous watery fluid begins to arise, the oil comes freely over with it, so as to render the liquor highly odorous, sapid, and of a milky hue.

The proof spirits usually met with in the shops are accompanied with a degree of ill flavour, which, though concealed by means of certain additions, plainly discovers itself in distillation. This nauseous flavour does not begin to arise till after the purer spiritous part has come over, which is the very time that the virtues of the ingredients begin also to arise most plentifully; and hence the liquor receives an ungrateful taint. To this cause principally is owing the general complaint, that the cordials of the apothecary are less agreeable than those of the same kind prepared by the distiller; the latter being extremely curious in rectifying or purifying the spirits (when designed for what he calls fine goods) from all unpleasant flavour.

Spiritus cari carvi, Edin. spirit of caraway. Take of caraway seeds half a pound; diluted alcohol nine pounds. Macerate two days in a close vessel; then pour on as much water as will prevent empyreuma, and draw off by distillation nine pounds.

Spiritus carvi, Lond. Dub. spirit of caraway. Take of caraway seeds, bruised, half a pound; proof spirit of wine one gallon; (nine pounds, Dub.) water sufficient to prevent empyreuma. Draw off one gallon, (nine pounds, Dub.)

In the same manner is prepared the same quantity of spirit from

Cinnamon, one pound,
  Spiritus lauri cinnamomi, Edin.
  Spiritus cinnamomi, Lond. Dub.
Peppermint, one pound and a half.
  Spiritus menthæ piperitæ, Edin.
  Spiritus menthæ piperitidis, Lond.
Spearmint, one pound and a half,
  Spiritus menthæ sativæ, Lond.
Pennyroyal dried, a pound and a half,
  Spiritus pulegii, Lond.
Nutmeg, well bruised, two ounces,
  Spiritus myristicæ moschatæ, Edin.
  Spiritus nucis moschatæ, Dub. Lond.
Pimento, half a pound,
  Spiritus myrti pimentæ, Edin.
  Spiritus pimento, Dub. Lond.

The rest belonging to this division are obtained from

Lavender,
  Spiritus lavendulæ, Lond.
  Spiritus lav. spicæ, Edin.
Rosemary,
  Spiritus rorismarini, Lond. Edin.
Anise, &c.
  Spiritus anisi compositus, Lond.
Juniper, &c.
  Spiritus juniperi compositus, Lond. Edin. Dub.
Horse-radish, &c.
  Spiritus raphani compositus, Lond. Dub.
Assafœtida,
  Spiritus Ammoniæ fœtidus, Lond.

Class X. *Decocta.* Decoctions.

Decoctions and infusions differ chiefly in the employment of boiling or of cold water. At the same time, however, that the increase of temperature in decoctions facili-

tates and expedites the solution of some fixed principles, it gives others a tendency to decomposition, and dissipates all volatile matters. Decoction, therefore, can only be used with advantage for the extraction of principles which are neither volatilized nor altered by a boiling heat.

To promote the action of the menstruum, infusion is sometimes premised to decoction.

In compound decoctions it is sometimes convenient not to put in all the ingredients from the first, but in succession, according to their hardness, and the difficulty with which their virtues are extracted; and if any aromatic, or other substances containing volatile principles, enter into the composition, the boiling decoction is to be simply poured upon them, and covered up until it cool.

Decoctions should be made in vessels sufficiently large to prevent any risk of boiling over, and should be continued without interruption, and gently.

The official preparations under this class are

Decoctum althææ officinalis, Edin. decoction of marshmallows.

Decoctum anthemidis nobilis, Edin. decoctum chamemæli, Lond. decoction of chamomile flowers.

Decoctum cinchonæ officinalis, Lond. Edin. decoction of Peruvian bark.

Decoctum daphnes mezerei, Edin. decoction of mezereon.

Decoctum geoffrææ inermis, Edin. decoction of cabbage-tree bark.

Decoctum guaiaci officinalis comp. Edin. decoction of the woods.

Decoctum hellebori albi, Lond. decoction of white hellebore.

Decoctum hordei Lond. hord. distichi, Edin. decoction of barley.

Decoctum polygalæ senegæ, Edin. decoction of seneka.

Decoctum sarsaparillæ, Lond. Dubl. decoctum smilacis sarsaparillæ, Edin. decoction of sarsaparilla.

Decoctum smilacis sarsaparillæ, Edin. decoctum smilacis sarsaparilla, comp. Dubl. Lond. decoction of compound of the same.

Decoctum ulmi, Lond. decoction of elm.

Class XI. *Infusa*. Infusions.

We have already explained the sense in which we employ the term infusion. We confine it to the action of a menstruum, not assisted by ebullition, on any substance consisting of heterogeneous principles, some of which are soluble, and others insoluble, in that menstruum. The term is generally used in a more extensive, but, we are inclined to think, a less correct sense. Thus, lime water and the mucilages, which are commonly classed with the infusions, are instances of simple solution, and the chalk mixture is the mechanical suspension of an insoluble substance. When the menstruum used is water, the solution is termed simply an infusion; but when the menstruum is alcohol, and upon a colouring material, it is called a tincture; when wine or vinegar, a medicated wine or vinegar. Infusions in water are extremely apt to spoil, and are generally extemporaneous preparations.

The following are those officially prescribed:

Infusum cinchonæ, Edin. infusion of Peruvian bark.

Infusum digitalis purpureæ, Edin. infusion of fox-glove.

Infusum gentianæ compositum Lond. infusum gentianæ luteæ comp. Edin. infusion of gentian, compound.

Infusum mimosæ catechu, Edin. infusion of catechu.

Infusum rhei palmati, Edin. infusion of rhubarb.

Infusum rosæ, Lond. infusum rosæ Gallicæ, Edin. infusion of roses.

Infusum sennæ, Lond. Dubl. infusion of senna.

Infusum sennæ tartarisatum, Lond. infusion of senna tartarised.

Infusum tamarindi Ind. cum cassia senna, Edin. infusion of tamarinds and senna.

Class XII. *Mucilagines*. Mucilages.

These, as officially prescribed, are as follow:

Mucilago amyli Lond. Edin. mucilage of starch.

Mucilago tragacanthæ, Lond. mucilago astragali tragac. Edin. mucilago gummi tragac. Dubl. mucilage of tragacanth.

Mucilago mimosæ niloticæ, Edin. mucilago gummi arabici, Lond. mucilage of gum arabic.

Mucilago sem. cydonii mali, Lond. mucilage of quince seed.

Class XII. *Syrupi*. Syrups.

In making these, the following is the proportion where no particulars are mentioned in respect to the weight of sugar.

Take of double-refined sugar twenty-nine

ounces; any kind of liquor one pint, (one pint and a half, Dubl.); dissolve the sugar in the liquor, in a water bath; (mix and boil down to one pound, Dubl.); then set it aside for twenty-four hours; take off the scum, and pour off the syrup from the feces if there be any.

Syrups are solutions of sugar in any watery fluid, whether simple or medicated. Simple syrup is nutritious and demulcent. When made of fine sugar, it is transparent and colourless. If necessary, it is easily clarified by beating to a froth the white of an egg with three or four ounces of water, mixing it with the syrup, and boiling the mixture for a few seconds, until the albumen coagulates, and enveloping all heterogeneous matters, it forms a scum, which may be easily taken off, or separated by filtration. When, instead of simple water, any other fluid is used for dissolving the sugar, the syrup is then medicated. Medicated syrups are prepared either with express juices, infusions, decoctions, or saline fluids. The object of forming these into syrups, is either to render them agreeable to the palate, or to preserve them from fermentation. In the latter case, the quantity of sugar added becomes a matter of great importance; for if too much be employed the sugar will separate by crystallization; and if too little, instead of preventing fermentation, it will accelerate it. About two parts of sugar to one of fluid are the proportions directed by the British Colleges with this view. But as, in some instances, a larger quantity of fluid is added, and afterwards reduced to the proper quantity by decoction, it will not be superfluous to point out some circumstances which show the evaporation to have been carried far enough. These are the tendency to form a pellicle on its surface, when a drop of it is allowed to cool, the receding of the last portion of each drop, when poured out drop by drop, after it is cold; and, what is most to be relied on, its specific gravity when boiling hot being about 1.385, or 1.3 when cold. The syrup which remains, after all the crystallizable sugar has been separated from it, has been much, and probably justly, recommended by some for the preparation of medicated syrups and electuaries, although its pharmaceutical superiority is actually owing to its impurity.

The following are the official preparations.

Syrupus simplex, Edin. simple syrup.

Syrupus acidi acetosi, Edin. syrup of acetous acid.

Syrupus allii, Dubl. syrup of garlic.

Syrupus altheæ, Lond. Edin. syrup of marshmallows.

Syrupus zingiberis, Lond. syrupus amomi zing. Edin. syrup of ginger.

Syrupus corticis aurantii, Lond. syrupus citri aurantii, Edin. syrup of orange-peel.

Syrupus limonis succi, Lond. Dubl. syrupus citri medici, Edin. syrup of lemons.

Syrupus succi fructus mori, Dubl. syrupus succi fructus rub. idæi, Lond. syrup of mulberries.

Syrupus succi fructus ribis nigri, Lond. syrup of black currants.

Syrupus colchici autumnalis, Edin. syrup of colchicum.

Syrupus caryophylli rubri, Lond. syrupus dianthi caryophylli, Edin. syrup of clove July flowers.

Syrupus croci, Lond. syrup of saffron.

Syrupus mannæ, Dubl. syrup of manna.

Syrupus papaveris somniferi, Edin. syrupus papaveris albi, Lond. syrup of white poppies.

Syrupus papaveris erratici, Lond. syrup of red poppies.

Syrupus opii, Dubl. syrup of opium.

Syrupus rhamni cathartici, Edin. syrupus spinæ cervin, Lond. syrup of buckthorn.

Syrupus rosæ, Lond. syrupus rosæ centifoliæ, Edin. syrup of damask roses.

Syrupus rosæ Gallicæ, Edin. syrup of roses.

Syrupus scillæ maritimæ, Edin. syrup of squills.

Syrupus tolutanus, Lond. syrupus toluiferæ balsami, Edin. syrup of balsam of tolu.

Syrupus violæ, Lond. syrupus violæ odoratæ, Edin. syrup of violets.

Class XIII. *Mellita*, Medicated Honeys.

Honey itself is first to be despumated or clarified by dissolving it in a water-bath, and removing the scum as it arises. The following preparations are then made of it.

Mel. acetatum, Lond. honey acetated, simple oxymel.

Oxymel colchici, Lond. oxymel of meadow saffron.

Mel. rosæ, Lond. Dubl. honey of roses.

Mel. scillæ, Lond. honey of squills.

Oxymel scillæ, Lond. oxymel of squills.

Oxymel æruginis, Lond. oxymel of verdigris.

Class XIV. *Misturæ et Emulsiones.* Mixtures and Emulsions.

This double class comprehends preparations in which oils and other substances, in-

soluble in water are mixed with, and suspended in, watery fluids, by means of such viscid substances as mucilages and syrups.

Emulsio amygdalæ communis, Edin. lac amygdalæ, Lond. almond emulsion.

Emulsio arabica, Edin. Dubl. gum arabic emulsion.

Emulsio camphorata, Edin. mistura camphorata, Lond. camphorated emulsion or mixture.

Lac ammoniaci, Lond. Dubl. emulsion of gum ammoniac.

Lac asæ fætidæ, Lond. emulsion of asafœtida.

Mistura moschata, Lond. musk mixture.

Mistura cretacea, Lond. chalk mixture.

Decoctum cornu cervi, Lond. decoction of hartshorn.

Class XV. *Aceta.* Medicated Vinegars.

Infusions of vegetable substances in acetic acid are commonly called medicated vinegars. The action of the acid in this case may be considered as twofold.

1. It acts simply as water, in consequence of the great quantity of water which enters into its composition, and generally extracts every thing which water is capable of extracting.

2. It exerts its own peculiar action as an acid. In consequence of this it sometimes increases the solvent power of its watery portion, or dissolves substances which water alone is incapable of dissolving, and in a few instances it impedes the solution of substances which water alone would dissolve.

As acetic acid, in itself sufficiently perishable, has its tendency to decomposition commonly increased by the solution of any vegetable matter in it, it should never be used as a menstruum, unless where it promotes the solution of the solvend, as in extracting the acrid principle of squills, colchicum, &c. and in dissolving the volatile, and especially the empyreumatic oils, or where it coincides with the virtues of the solvend.

Acetum aromaticum, Edin. aromatic vinegar, thieves vinegar.

Acetum colchici, Dub. vinegar of meadow saffron.

Acetum scilliticum, Lond. acetum scillæ maritimæ, Edin. vinegar of squills.

Acidum acetosum camphoratum, Edin. camphorated acetous acid.

Class XVI. *Tincturæ.* Tinctures.

The term tincture has often been employed in a very vague sense. It is now commonly applied to coloured solutions, made by digestion, in alcohol, or diluted alcohol. But it is also, though perhaps incorrectly, extended to solutions in ether, ethereal spirits, and spirit of ammonia.

Alcohol is capable of dissolving resins, gum resins, extractive, tannin, sugar, volatile oils, soaps, camphor, adipocere, colouring matters, acids, alkalies, and some compound salts. Many of these, as the gum resins, soaps, extractive, tannin, sugar, and saline substances, are also soluble in water, while water is capable of dissolving substances, such as gum, gelatine, and most of the compound salts, which are insoluble in alcohol. But the insolubility of these substances in the different menstrua is not absolute, but merely relative; for a certain proportion of alcohol may be added to a solution of gum in water without decomposing it; and a solution of resin in alcohol will bear a certain admixture of water without becoming turbid. Therefore, diluted alcohol, which is a mixture of these two menstrua, sometimes extracts the virtues of heterogeneous compounds more completely than either of them separately.

Alcohol is used as a menstruum.

1. When the solvend is not soluble, or sparingly soluble, in water.

2. When a watery solution of the solvend is extremely perishable.

3. When the use of alcohol is indicated as well as that of the solvend.

In making alcoholic tinctures, we must observe, that the virtues of recent vegetable matters are very imperfectly extracted by spirituous menstrua. They must therefore be previously carefully dried, and as we cannot assist the solution by means of heat, we must facilitate it by reducing the solvend to a state of as minute mechanical division as possible. To prevent loss, the solution is commonly made in a close vessel, and the heat applied must be very gentle, lest it be broken by the expansion of vapour.

The action of tinctures on the living system is always compounded of the action of the menstruum, and of the matters dissolved in it. Now, these actions may either coincide with, or oppose, each other; and as alcohol is at all times a powerful agent, it is evident that no substance should be exhibited in the form of a tincture, whose action is different from that of alcohol, unless it be capable of operating in so small a

dose, that the quantity of alcohol taken along with it is inconsiderable.

Tinctures are not liable to spoil, as it is called, but they must nevertheless be kept in well closed phials, especially when they contain active ingredients, to prevent the evaporation of the menstruum.

They generally operate in doses so small, that they are rarely exhibited by themselves, but commonly combined with some vehicle. In choosing the latter, we must select some substance which does not decompose the tincture, or at least separates nothing from it in a palpable form.

The London college direct all tinctures, except that of muriate of iron, to be prepared in closed phials.

The Dublin college explain, that, when they order substances to be digested, they mean it be done with a low degree of heat; and when they are to be macerated, it is to be done with a degree of heat between 60° and 90°.

Tinctura aloes, Lond. tinctura succotorinæ, Edin. tincture of aloes.

Tinctura aloes composita, Lond. tinctura aloes cum myrrha, Edin. tincture of aloes with myrrh.

Tinctura cardemomi, Lond. tinctura amomi repentis, Edin. tincture of cardamoms.

Tinctura serpentariæ, Lond. tinctura aristolochiæ serpentariæ, Edin. tincture of snake-root.

Tinctura assæ fætidæ, Lond. Dubl. tincture of asafœtida.

Tinctura aurantii corticis, Lond. Dubl. tincture of orange-peel.

Tinctura balsami peruviani, Lond. tincture of balsam of Peru.

Tinctura benzoes composita, Lond. Edin. tincture of benjamin, compound.

Tinctura camphoræ, Edin. spiritus camphoratus, Lond. Dub. tincture of camphor, camphorated spirit.

In this the Edinburgh title is grossly inaccurate; the preparation being quite colourless instead of tinctured.

Tinctura cascarillæ, Lond. Dubl. tincture of cascarilla.

Tinctura sennæ, Lond. Dubl. tincture of senna.

Tinctura cassiæ sennæ composita, Edin. tincture of senna compound; elixir of health.

Tinctura castorei, Lond. Dub. tincture of castor.

Tinctura cinchonæ, Lond. Edin. tincture of Peruvian bark.

Tinctura cinchonæ composita, Lond. Dubl. tincture of Peruvian bark, compound.

Tinctura columbæ, Lond. Edin. Dubl. tincture of Columbo.

Tinctura jalapæ, Lond. Dubl. tinctura convolvuli jalapæ, Edin. tincture of jalap.

Tinctura croci, Edin. tincture of saffron.

Tinctura digitalis purpureæ, Edin. tincture of foxglove.

Tinctura galbani, Lond. tincture of galbanum.

Tinctura gentianæ composita, Lond. Edin. tincture of gentian, compound.

Tinctura guaiaci, Edin. tincture of guaiacum.

Tinctura hellebori nigri, Lond. Dubl. tincture of black hellebore.

Tinctura hyosciami nigri, Edin. tincture of henbane.

Tinctura kino, Edin. Dubl. tincture of kino.

Tinctura cinnamomi, Lond. Dubl. tinctura lauri cinnamomi, Edin. tincture of cinnamon.

Tinctura lauri cinnamomi composita, Edin. Lond. tincture of cinnamon, compound.

Tinctura lavendula comp. Dubl. spiritus lavendulæ comp, Lond. spiritus lavendulæ spicæ comp. Edin. tincture of lavender, and spirit of lavender.

Here the Dublin title is wrong; the tincture is not derived from the lavender, but from the red saunders.

Tinctura cantharidis, Lond. Dubl. tinctura meloes vesicatorii, Edin. tincture of cantharides.

Tinctura misosæ catechu, Edin. tincture of catechu.

Tinctura moschi, Dubl. tincture of musk.

Tinctura myrrhæ, Lond. Edin. Dubl. tincture of myrrh.

Tinctura opii, Lond. Edin. Dubl. tincture of opium.

Tinctura opii camphorata, Lond. Dubl. tincture of opium camphorated.

Tinctura rhabarbari, Lond. Dubl. tinctura rhei palmati, Edin. tincture of rhubarb.

Tinctura rhabarbari composita, Lond. tincture of rhubarb, compound.

Tinctura rhei cum aloe, Edin. tincture of rhubarb with aloes.

Tinctura rhei cum gentiana, Edin. tincture of rhubarb with gentian.

Tinctura sabinæ composita, Lond. tincture of savin, compound.

Tinctura saponis, Edin. lininimentum saponis compositum, Lond. lininimentum saponaceum, tincture of opodeldoc.

Tinctura saponis cum opio, Edin. anodyne liniment.

Tinctura scillæ, Lond. Dubl. tincture of squill.

Tinctura bals. tolutani, Lond. Dubl. tinc-

tura toluiferæ balsamic, Edin. tincture of balsam of tolu.

Tinctura valerianæ, Lond. tincture of valerian.

Tinctura veratri albi, Edin. tincture of white hellebore.

Tinctura zingiberis, Lond. tincture of ginger.

Class XVII. *Ætherea*, Etherial Spirits.

Alcohol, alcohol.

Æther sulphuricus, Edin. æther vitriolicus, Lond. Dubl. sulphuric ether, vitriolic ether.

Æther sulphuricus cum alcohole, Edin. spiritus etheris vitriolici, Lond. spirit of ether.

Oleum vini, Lond. oil of wine.

Spiritus ætheris vitriolici comp. Lond. Hoffman's anodyne liquor.

Spiritus ætheris nitrosi, Lond. Edin. spirit of nitrous ether.

Linimentum camphoræ compositum, Lond. compound camphor liniment.

Linimentum volatile, Dubl. volatile liniment.

Alcohol ammoniatum aromaticum, Edin. spiritus ammoniæ compositus, Lond. sal volatile.

Spiritus ammoniæ succinatus, Lond. amber, spirit of ammonia, or eau de luce.

Tinctura castorei composita, Edin. compound tincture of castor.

Tinctura cinchonæ ammoniata, Lond. ammoniated tincture of cinchona.

Tinctura guaiaci ammoniata, Edin. Lond. tincture of guiacum.

Tinctura opii ammoniata, Edin. tincture of opium.

Tinctura valerianæ ammoniata, Lond. Dubl. tincture of valerian.

Class XVIII. *Vina*. Medicated Wines.

M. Parmentier has occupied thirty-two pages of the Annales de Chimie, to prove that wine is an extremely bad menstruum for extracting the virtues of medicinal substances. His argument, (for there is but one), is, that by the infusion of vegetable substances in wine, its natural tendency to decomposition is so much accelerated, that at the end of the process, instead of wine, we have only a liquor containing the elements of bad vinegar. As a solvent, diluted alcohol perfectly supersedes the use of wine; and if we wish to use wine to cover the taste, or to assist the operation of any medicine, M. Parmentier proposes, that a tincture of the substance should be extemporaneously mixed with wine as a vehicle.

Notwithstanding this argument appears to us to have great weight, we shall allow to the medicated wines, retained in the pharmacopœias, the characters they still generally possess.

Vinum aloes, Lond. vinum aloes succotorinæ Edin. wine of aloes.

Vinum gentianæ compositum, Edin. wine of gentian, compound.

Vinum ipecacuanhæ, Lond. Dubl. wine of ipecacuan.

Vinum nicotianæ tabaci, Edin. wine of tobacco.

Vinum rhabarbari, Lond. vinum rhei palmati, Edin. wine of rhubarb.

The metallic wines have been noticed already.

Class XIX. *Extracta*. Extracts.

Extract, in pharmacy, has been long used in the true and general sense of the term, to express a substance extracted from bodies of all kinds, by the action of whatever menstruum, and reduced to spissitude by the evaporation of that menstruum. Of late, however, it has been employed in a different and more limited sense, as the name for a peculiar principle, which is often indeed, contained in extracts, and which before had no proper appellation. It is in the former sense that we employ it here, and in which we wish it to be only used, while a new word should be invented as the name of the new substance. Till a better be proposed, we shall call it extractive.

Extracts are of various kinds, according to the nature of the substances from which they are obtained, and the menstruum employed; but they commonly consist of gum, sugar, extractive, tannin, gallic acid, or resin, or several of them mixed in various proportions. The menstrua most commonly employed are water and alcohol. The former is capable of extracting all the substances enumerated, except the resin, and the latter all except the gum. Wine is also sometimes employed, but very improperly; for as a solvent it can only act as a mixture of alcohol and water, and the principles which it leaves behind on evaporation are rather injurious than of advantage to the extract.

Water is the menstruum most economically employed in making extracts, as it is

capable of dissolving all the active principles except resin, and can have its solvent powers assisted by a considerable degree of heat.

Watery extracts are prepared by boiling the subject in water, and evaporating the strained decoction to a thick consistence.

It is indifferent, with regard to the medicine, whether the subject be used fresh or dry; since nothing that can be preserved in this process will be lost by drying. With regard to the facility of extraction, there is a very considerable difference; vegetables in general giving out their virtues more readily when moderately dried than when fresh.

Very compact dry substances should be reduced into exceedingly small parts, previous to the affusion of the menstruum.

The quantity of water ought to be no greater than is necessary for extracting the virtues of the subject. This point, however, is not very easily ascertained; for although some of the common principles of extracts be soluble in a very small proportion of water, there are others, such as the tannin, of which water can dissolve only a certain proportion, and cannot be made to take up more by any length of boiling, and we have no very good method of knowing when we have used a sufficient quantity of water; for vegetable substances will continue to colour deeply successive portions of water boiled with them, long after they are yielding nothing to it but colouring matter. Perhaps one of the best methods is to boil the subject in successive quantities of water, as long as the decoctions form a considerable precipitate with the test which is proper for detecting the substance we are extracting, such as a solution of gelatine for tannin, of alum for extractive, &c.

"The decoctions are to be depurated by colature; and afterwards suffered to stand for a day or two, when a considerable quantity of sediment is usually found at the bottom. If the liquor poured off clear be boiled down a little, and afterwards suffered to cool again, it will deposit a fresh sediment, from which it may be decanted before you proceed to finish the evaporation. The decoctions of very resinous substances do not require this treatment, and are rather injured by it; the resin subsiding along with the inactive dregs."

Such are the directions given in most of Dr. Duncan's editions of the New Edinburgh Dispensatory, for the depuration of the decoctions, and we have inserted them at full length, because, although we doubt very much of their propriety, our reasons for so doing are scarcely more than hypothetical. We would advise the decoctions to be evaporated after they have been filtered boiling hot, without any further depuration; because some of the most active principles of vegetable substances, such as tannin, are much more soluble in boiling than in cold water, and because almost all of them are very quickly affected by exposure to the atmosphere. Therefore, if a boiling decoction, saturated with tannin, be allowed to cool, the greatest part of the very principle on which the activity of the substance depends will separate to the bottom, and according to the above directions, will be thrown away as sediment. The same objection applies more strongly to allowing the decoction to cool, and deposit a fresh sediment, after it has been partially evaporated. Besides, by allowing the decoctions to stand several days before we proceed to their evaporation, we are in fact allowing the active principles contained in the decoction to be altered by the action of the air, and to be converted into substances, perhaps inactive, which also are thrown away as sediment.

The evaporation is most conveniently performed in broad shallow vessels: the larger the surface of the liquor, the sooner will the aqueous parts exhale. This effect may likewise be promoted by agitation.

When the matter begins to grow thick, great care is necessary to prevent its burning. This accident, almost unavoidable if the quantity be large, and the fire applied as usual under the evaporating pan, may be effectually prevented, by carrying on the inspissation, after the common manner, no further than the consistence of a syrup, when the matter is to be poured into shallow tin or earthen pans, and placed in an oven, with its door open, moderately heated; which acting uniformly on every part of the liquid, will soon reduce it to any degree of consistence required. This may likewise be done, and more securely, by setting the evaporating vessel in boiling water: but the evaporation is in this way very tedious.

Alcohol is much too expensive to be employed as a menstruum for obtaining extracts, except in those cases where water is totally inadequate to the purpose. These cases are, 1. When the nature of the extract is very perishable when dissolved in water, so that it is liable to be decomposed before the evaporation can be completed, especially if we cannot proceed immediate-

ly to the evaporation. 2. When water is totally incapable of dissolving the substance to be extracted; and, 3. When the substance extracted can bear the heat of boiling alcohol without being evaporated, but would be dissipated by that of boiling water; that is, when it requires a heat greater than 176°, and less than 212°, for its vaporization.

In the last case, the alcohol must be perfectly free from water, because the heat necessary to evaporate it at the end of the process would frustrate the whole operation. Hence, also, the subject itself ought always to be dry: those substances which lose their virtue by drying, lose it equally on being submitted to this treatment with the purest alcohol.

In this way the alcoholic extract of some aromatic substances, as cinnamon, lavender, rosemary, retain a considerable degree of their fine flavour. In the second case, the alcohol need not be so very strong, because it is still capable of dissolving resinous substances, although diluted with a considerable proportion of water. In the first case, the alcohol may be still much weaker: or rather, the addition of a small proportion of alcohol to water will be sufficient to retard or prevent the decomposition of the decoction.

The alcohol employed in all these cases should be perfectly free from any unpleasant flavour, lest it be communicated to the extract.

The inspissation should be performed from the beginning, in the gentle heat of a water-bath. We need not suffer the alcohol to evaporate in the air: the greatest part of it may be recovered by collecting the vapour in common distilling vessels. If the distilled spirit be found to have brought over any flavour from the subject, it may be advantageously reserved for the same purposes again.

When diluted alcohol is employed, the distillation should only be continued as long as alcohol comes over; and the evaporation should be finished in wide open vessels.

Pure resins are prepared, by adding to spiritous tinctures of resinous vegetables a large quantity of water. The resin, incapable of remaining dissolved in the watery liquor, separates and falls to the bottom, leaving in the menstruum such other principles of the plant as the spirit might have extracted at first along with it. But this is only practised for the purpose of analysis.

Extracts made with Water only.

Extractum gentianæ luteæ, Edin. extract of gentian. Having cut and bruised any quantity of gentian, pour upon it eight times its quantity of water. Boil to the consumption of one half of the liquor, and strain it by strong expression. Evaporate the decoction immediately to the consistence of thick honey, in a bath of water saturated with muriate of soda.

In the same manner are prepared extracts

Of the roots of liquorice, extractum glycyrrhizæ glabræ.

Of the roots of black hellebore, extractum hellebori nigri.

Of the leaves of rue, extractum rutæ graveolentis.

Of the leaves of senna, extractum cassiæ sennæ.

Of the flowers of camomile, extractum anthemidis nobilis (chamæmeli).

Of the heads of white poppy, extractum papaveris albi.

Of logwood, extractum hæmatoxyli Campechiensis.

Extract of broom tops, extractum cacuminis genistæ.

Extract of camomile, extractum chamæmeli.

Extract of savin, extractum sabinæ.

The other extracts of this division are,

Extractum cinchonæ, Lond. extract of Peruvian bark.

Extractum hæmatoxyli, Lond. extract of logwood.

Extractum opii, Dubl. extract of opium.

Extractum sennæ, Lond. extract of senna.

Extracts made with Alcohol and Water.

Extractum cinchonæ officinalis, Edin. extractum cinchonæ cum resina, Lond. resin of bark.

Extractum radicis convolvuli jalapæ, Edin. extractum jalapii, Lond. resin of jalap.

Extractum cascarillæ, Lond. resin of cascarilla.

Extractum colocynthidis compositum, compound extract of colocynth.

CLASS XX. *Pulveris.* POWDERS.

This form is proper for such materials only as are capable of being sufficiently dried to become pulverisable without the

loss of their virtue. There are several substances, however, of this kind, which cannot be conveniently taken in powder; bitter, acrid, fœtid drugs are too disagreeable; emollient and mucilaginous herbs and roots are too bulky; pure gums cohere, and become tenacious in the mouth: fixed alkaline salts deliquesce when exposed to the air, and volatile alkalies exhale. Many of the aromatics, too, suffer a great loss of their odorous principles when kept in powder; as in that form they expose a much larger surface to the air.

The dose of powders, in extemporaneous prescription, is generally about half a drachm: it rarely exceeds a whole drachm; and is not often less than a scruple. Substances which produce powerful effects in smaller doses are not trusted to this form, unless their bulk be increased by additions of less efficacy; those which require to be given in larger ones are better fitted for other forms.

The usual vehicle for taking the lighter powders, is any agreeable thin liquid. The ponderous powders, particularly those prepared from metallic substances, require a more consistent vehicle, as syrups; for from thin ones they soon subside: resinous substances likewise are most commodiously taken in thick liquors, for in thin ones they are apt to run into lumps, which are not easily again soluble.

Pulvis aloes cum canella, Lond. powder of aloes with canella.

Pulvis aloeticus cum guaiaco, Lond. powder aloetic with guaiacum.

Pulvis aloeticus cum ferro, Lond. powder aloetic with iron.

Pulvis aromaticus, Lond. Dubl. powder aromatic.

Pulvis asari compositus, Lond. Dubl. powder of asarabacca compound.

Pulvis cretæ compositus, Lond. pulvis carbonatis calcis comp. Edin. powder of chalk, compound.

Pulvis cretæ compositus cum opio, Lond. powder of chalk, compound with opium.

Pulvis chelarum cancri compositus, Lond. powder of crab's claws, compound.

Pulvis cerussæ compositus, Lond. powder of ceruse, compound.

Pulvis contrayervæ comp. Lond. powder of contrayerva, compound.

Pulvis ipecacuanhæ comp. Lond. pulvis ipecacuanhæ et opii. Edin. powder of Dover's.

Pulvis myrrhæ comp. Lond. powder of myrrh compound.

Pulvis scammonii comp. Lond. Edin. Dubl. powder of scammony, compound.

Pulvis scammonii comp. cum aloe, Lond. powder of scammony compound with aloes.

Pulvis scammonii comp. cum calomelane, Lond. powder of scammony with calomel.

Pulvis sennæ compositus, Lond. powder of senna, compound.

Pulvis sulphatis aluminæ comp. Edin. powder of styptic.

Pulvis tragacanthæ compositus, Lond, powder of tragacanth, compound.

Class XXI. *Confectiones.* Confections.

Under this title we include all those preparations which have hitherto been loosely denominated conserves, electuaries, and confections; the difference in the preparation of which being too trifling for distinct heads.

Confections are, for the most part, compositions of recent vegetable matters and sugar, beaten or otherwise mixed together into an uniform mass. The sugar should be pounded by itself, and passed through a sieve before it be mixed with the vegetable mass, for without this it cannot be properly incorporated. It is obvious that, from the large admixture of sugar, only substances of considerable activity can be taken with advantage in this form. Conserves are hence, for the most part, only auxiliary to medicines of greater activity; as, for example, for reducing into boluses or pills the more ponderous powders, as calomel, oxides of iron, and other mineral preparations.

Electuaries are composed chiefly of powders mixed up with syrups, &c. into such a consistence, that the powders may not separate in keeping, that a dose may be easily taken up on the point of a knife, and not prove too stiff to swallow.

Electuaries receive chiefly the milder alterative medicines, and such as are not ungrateful to the palate. The more powerful drugs, as cathartics, emetics, opiates, and the like (except in officinal electuaries to be dispensed by weight), are seldom trusted in this form, on account of the uncertainty of the dose: disgustful ones, acrids, bitters, fœtids, cannot be conveniently taken in it; nor is the form of an electuary well fitted for the more ponderous substances, as mercurials, these being apt to subside on keeping, unless the composition be made very stiff.

The lighter powders require thrice their weight of honey, or syrup boiled to the thickness of honey, to make them into the consistence of an electuary: of syrups of the common consistence, twice the weight of the powder is sufficient.

Where the common syrups are employed, it is necessary to add likewise a little conserve, to prevent the compound from candying and drying too soon. Electuaries of Peruvian bark, for instance, made up with syrup alone, will often, in a day or two, grow too dry for taking.

This is owing to the crystallization of the sugar. Deyeux, therefore, advises electuaries, confections, and conserves, to be made up with syrups from which all the crystallizable parts have been separated. For this purpose, after being sufficiently evaporated, they are to be exposed to the heat of a stove as long as they form any crystals. The syrup which remains, probably from the presence of some vegetable acid, has no tendency to crystallize, and is to be decanted and evaporated to a proper consistence. In hospital practice, the same object may be obtained much more easily by using molasses instead of syrups.

The quantity of an electuary, directed at a time, in extemporaneous prescription, varies much according to its constituent parts, but is rarely less than the size of a nutmeg, or more than two or three ounces.

The conservæ are,

Citri aurantii, Edin. aur. hispalensis, Lond. conserve of orange peel.

Rosæ caninæ, Edin. cynosbati, Lond. conserve of hips.

Rosæ rubræ, Edin. Lond. rosæ, Dubl. conserve of red rose buds.

Lujulæ, Lond. acetosellæ, Dubl. conserve of wood sorrel.

Pluck the leaves from the stalks, the unblown petals from the cups, taking off the heels. Take the outer rind of the oranges by a grater.

When prepared in this way, beat them with a wooden pestle in a marble mortar, first by themselves, afterwards with three times their weight of double refined sugar, until they be mixed.

The only exceptions to these general directions, which are those of the London college, are, that the London college adds only twenty ounces of sugar to one pound of the pulp of hips, and that the Dublin add only twice their weight of sugar to the sorrel leaves. La Grange says, that by infusing the red rose leaves in four times their weight of water, which is afterwards to be expressed from them, they lose their bitterness, and are more easily reduced to a pulp, which he then mixes with a thick syrup, prepared by dissolving the sugar in the expressed liquor, and boiling it down to the consistence of an electuary.

It is scarcely necessary to make any particular remarks on these conserves. Their taste and virtues are compounded of those of sugar, and the substance combined with it. The wood sorrel and hips are acidulous and refrigerant; the orange-rind and wormwood bitter and stomachic, and the red rose buds astringent.

The electuaries and confections are as follow:

Electuarium cassiæ, Lond. Dubl. electuarium cassiæ fistulæ, Edin. electuary of cassia.

Electuarium cassiæ sennæ, Edin. electuarium sennæ, Lond. electuary lenitive.

Electuarium catechu, Edin. electuary of catechu.

Electuarium catechu comp. Dubl. electuary of catechu, compound.

Electuarium scammonii, Lond. Dubl. electuary of scammony.

Electuarium opiatum, Edin. confectio opiata, Lond. electuary of opium, opiate confection.

Confectio aromatica, Lond. aromatic confection.

Class XXII. Trochisci, Troches.

Troches and lozenges are composed of powders made up with glutinous substances into little cakes, and afterwards dried. This form is principally made use of for the more commodious exhibition of certain medicines, by fitting them to dissolve slowly in the mouth, so as to pass by degrees into the stomach; and hence these preparations have generally a considerable proportion of sugar or other materials grateful to the palate. Some powders have likewise been reduced into troches, with a view to their preservation; though possibly for no very good reasons; for the moistening, and afterwards drying them in the air, must in this light be of greater injury than any advantage accruing from this form can counterbalance.

Trochisci cretæ, Lond. trochisci carbonatis calcis, Edin. troches of chalk.

Trochisci glycirrhizæ, Lond. Dubl. troches of liquorice.

Trochisci glycirrhizæ cum opio, Edin. Dubl. troches of liquorice with opium.

Trochisci amyli, Lond. troches of starch.

Trochisci gummosi, Edin. troches of starch with gum arabic.

Trochisci magnesiæ, Lond. troches of magnesia.

Trochisci nitri, Lond. trochisci nitratis potassæ, Edin. troches of nitre.

Trochisci sulphuris, Lond. troches of sulphur.

Class XXIII. *Pilulæ*. Pills.

The masses for pills are best kept in bladders, which should be moistened now and then with some of the same kind of liquid that the mass was made up with, or with some proper aromatic oil. When the mass is to be divided into pills, a given weight of it is rolled out into a cylinder of a given length, and of an equal thickness throughout, and is then divided into a given number of equal pieces, by means of a simple machine. These pieces are then rounded between the fingers; and, to prevent them from adhering, they are covered either with starch, or powder of liquorice, or orris root. In Germany the powder of lycopodium is much used.

To this form are peculiarly adapted those drugs which operate in a small dose, and whose nauseous and offensive taste or smell require them to be concealed from the palate.

Pills should have the consistence of a firm paste, a round form, and a weight not exceeding five grains. Essential oils may enter them in small quantity; deliquescent salts are improper. Efflorescent salts such as carbonate of soda, should be previously exposed so as to fall to powder: deliquescent extracts should have some powder combined with them. The mass should be beaten until it become perfectly uniform and plastic. Powders may be made into pills with extracts, balsams, soap, mucilages, bread-crumb, &c.

Gummy resins, and inspissated juices, are sometimes soft enough to be made into pills, without addition: where any moisture is requisite, spirit of wine is more proper than syrups or conserves, as it unites more readily with them, and does not sensibly increase their bulk. Light dry powders require syrup or mucilages: and the more ponderous, as the mercurial and other metallic preparations, thick honey, conserve, or extracts.

Light powders require about half their weight of syrup; or of honey, about three fourths their weight: to reduce them into a due consistence for forming pills. Half a drachm of the mass will make five or six pills of a moderate size.

Gums and inspissated juices are to be first softened with the liquid prescribed: the powders are then to be added, and the whole beat thoroughly together, till they be perfectly mixed.

Pilulæ aloeticæ, Edin. Dubl. pills aloetic.

Pilulæ aloes compositæ, Lond. pills aloetic, compound.

Pilulæ aloes cum assafœtida, Edin. pills aloetic with assafœtida.

Pilulæ aloes cum colocynthide, Edin. pills aloetic with colocynth.

Pilulæ aloes cum myrrha, Lond. pills aloetic with myrrh.

Pilulæ assafœtida compositæ, Edin. pills of assafœtida, compound.

Pilulæ galbani compositæ, Lond. pills of galbanum, compound.

Pilulæ ammoniareti cupri, Edin. pills of ammoniaret of copper.

Pilulæ hydrargyri, Lond. Edin. Dubl. pills of quicksilver.

Pilulæ opii, Lond. pilulæ opiatæ, Edin. pills of opium.

Pilulæ rhei compostæ, Edin. pills of rhubarb, compound.

Pilulæ scillæ, Lond. Dubl. Edin. pills of squills.

Pilulæ stibii compositæ, Dubl. pills of antimony, compound; Plummer's.

The common mercurial pill is one of the best preparations of mercury, and may, in general, supersede most other forms of this medicine. In its preparation the mercury is minutely divided, and probably converted into the black oxide. To effect its mechanical division it must be triturated with some viscid substance. Soap, resin of guaiac, honey, extract of liquorice, manna, and conserve of roses, have all been at different times recommended. The soap and guaiac have been rejected, on account of their being decomposed by the juices of the stomach; and the honey, because it was apt to gripe some people. With regard to the others, the grounds of selection are not well understood; perhaps the acid contained in the conserve of roses may contribute to the extinction of the mercury. We learn when the mercury is completely extinguished, most easily, by rubbing a very little of the mass with the point of the finger on a piece of paper, if no globules ap-

pear. As soon as this is the case, it is necessary to mix with the mass a proportion of some dry powder, to give it a proper degree of consistency. For this purpose powder of liquorice root has been commonly used; but it is extremely apt to become mouldy, and to cause the pills to spoil. The Edinburgh College have, therefore, with great propriety, substituted for its starch, which is a very inalterable substance, and easily procured at all times in a state of purity. It is necessary to form the mass into pills immediately, as it soon becomes hard. One grain of mercury is contained in four grains of the Edinburgh mass, in three of the London, and in two and a half of the Dublin. The dose of these pills must be regulated by circumstances; from two to six five-grain pills may be given daily.

Class XXIV. *Cataplasmata.* Cataplasms.

By cataplasms are generally understood those external applications which are brought to a due consistence or form for being properly applied, not by means of oily or fatty matters, but by water or watery fluids. Of these many are had recourse to in actual practice; but they are seldom prepared in the shops of the apothecaries, and in some of the best modern Pharmacopœias no formula of this kind is introduced. The London and Dublin Colleges, however, although they have abridged the number of cataplasms, still retain a few; and it is not without some advantage that there are fixed forms for the preparation of them.

Cataplasma aluminis, Lond. Coagulum aluminis, Dubl. cataplasm of alum, alum curd.

Cataplasma cumini, Lond. cataplasm of cummin, London treacle.

Cataplasma sinapeos, Lond. Dubl. cataplasm of mustard.

Cataplasms of mustard are commonly known by the name of sinapisms. They were formerly frequently prepared in a more complicated state, containing garlic, black soap, and other similar articles; but the above simple form will answer every purpose which they are capable of accomplishing. They are employed only as stimulants: they often inflame the part and raise blisters, but not so perfectly as cantharides. They are frequently applied to the soles of the feet in the low state of acute diseases, for raising the pulse and relieving the head. The chief advantage they have depends on the suddenness of their action.

Class XXV. *Linimenta.* Liniments.
Class XXVI. *Unguenta.* Ointments.
Class XXVII. *Cerata.* Cerates.
Class XXVIII. *Emplastra.* Plasters.

We connect these together as being all oleaginous or fatty combinations for external application, and as merely differing from each other in their degree of consistency. Deyeux has, indeed, lately defined plasters to be combinations of oil with metallic oxides; but as this would comprehend many of our present ointments, and exclude many of our plasters, we shall adhere to the old meaning of the terms.

Liniments are the thinnest of these compositions, being only a little thicker than oil.

Ointments have generally a degree of consistence like that of butter.

Cerates are firmer, and contain a larger proportion of wax.

Plasters are the most solid, and when cold should be firm, and not adhere to the fingers; but when gently heated should become sufficiently soft to spread easily, and should then adhere to the skin. Plasters derive their firmness either from a large proportion of wax, resin, &c. or from the presence of some metallic oxide, such as that of lead.

Plasters should have such a consistence, that although when cold they do not adhere to the fingers, they become soft and plastic when gently heated. The heat of the body should render it tenacious enough to adhere to the skin, and to the substance on which it is spread. When prepared, it is usually formed into rolls, and inclosed in paper. Plasters of a small size are often spread on leather, sometimes on strong paper, by means of a spatula gently heated, or the thumb. The leather is cut of the shape wanted, but somewhat larger; and the margin all round, about a quarter of an inch in breadth, is left uncovered, for its more easy removal when necessary. Linen is also often used, especially for the less active plasters, which are used as dressings, and often renewed. It is generally cut into long slips of various breadths, from one to six inches. These may either be dipped into the melted plaster, and passed through two pieces of straight and smooth wood, held firmly together, so as to remove any excess of plaster; or, what is more elegant, they are spread on one side only, by stretching the linen, and applying the plaster, which has been melted and allowed to become almost cold, evenly

by means of a spatula, gently heated, or, more accurately, by passing the linen on which the plaster has been laid, through a machine formed of a spatula fixed, by screws, at a proper distance from a plate of polished steel.

To prevent repetition, the Edinburgh College give the following canon for the preparation of these substances:

"In making these compositions, the fatty and resinous substances are to be melted with a gentle heat, and then constantly stirred; adding, at the same time, the dry ingredients, if there be any, until the mixture, on cooling, becomes stiff."

Linimentum simplex, Edin. simple liniment, wax and oil.

Oleum ammoniatum, Edin. linimentum ammoniæ, Lond. oil or liniment of ammonia, volatile liniment.

Linimentum ammoniæ fortius, Lond. volatile liniment, stronger.

Oleum lini cum calce, Edin. linseed oil with lime.

Oleum camphorat. Ed. camphorated oil.

Unguentum adipis suillæ, Lond. ointment of hogs' lard.

Unguentum simplex, Edin. ointment of simple wax and oil.

Unguentum spermatis ceti, Lond. Dubl. ointment of spermaceti.

Unguentum ceræ, Lond. Dubl. ointment of wax.

Unguentum acidi nitrosi, Edin. ointment of nitrous acid.

Unguentum resinæ flavæ, Lond. Dubl. ointment of yellow resin.

Unguentum elemi, Dubl. unguentum elemi compositum, Lond. ointment of elemi.

Unguentum picis, Lond. Dubl. ointment of tar.

Unguentum sambuci, Lond. Dubl. ointment of elder.

Unguentum cantharidis, Lond. Dubl. ointment of cantharides.

Unguentum infusi meloes vesicatorii, Edin. ointment of mild epispastic.

Unguentum pulveris meloes vesicatorii, Edin. ointment of stronger epispastic.

Unguentum hellebori albi, Lond. Dubl. ointment of white hellebore.

Unguentum sulphuris, Lond. Dubl. ointment of sulphur.

Unguentum oxidi plumbi albi, Edin. ointment of oxide of white lead.

Unguentum acetitis plumbi, Edin. the acetite of lead, saturnine ointment.

Unguentum cerussæ acetatæ, Lond. Dubl. ointment of acetated ceruse.

Unguentum hydrargyri, Edin. ointment of quicksilver.

Unguentum hydrargyri fortius, Lond. Dubl. ointment of quicksilver, stronger.

Unguentum hydrargyri mitius, Lond. Dubl. ointment of quicksilver, milder.

Unguentum calcis hydrargyri albi, Lond. ointment of white precipitate.

Unguentum calcis hydrargyri rubri; Lond. ointment of red precipitate.

Unguentum nitratis hydrargyri, Edin. citrine ointment.

Unguentum subacititis cupri, Edin. ointment of verdigris.

Unguentum oxidi zinci impuri, unguentum tutiæ, Lond. Dubl. ointment of tutty.

Unguentum oxidi zinci, Edin. ointment of oxide of zinc.

Ceratum simplex, Edin. ceratum spermatis ceti, Lond. Dubl. cerate of spermaceti.

Ceratum resinæ flavæ, Lond. Dubl. cerate of yellow resin.

Ceratum cantharidis, Lond. Dubl. cerate of cantharides.

Ceratum saponis, Lond. Dubl. cerate of soap.

Ceratum lithargyri acetati compositum, Lond. saturnine cerate.

Ceratum carbonatis zinci impuri, Edin. cerate of carbonate of zinc.

Ceratum lapidis calaminaris, Lond. Dubl. cerate of calamine epulotic, Turner's.

Emplastrum ceræ, Dubl. emplastrum ceræ compositum, Lond. emplastrum simplex, Edin. plaster of wax, drawing.

Emplastrum picis Burgundicæ, Dubl. emplastrum picis Burgundicæ composit. Lond. plaster of Burgundy pitch.

Emplastrum cumini, Lond. plaster of cummin.

Emplastrum ladani compositum, plaster of laudanum compound.

Emplastrum cantharidis, Lond. Dubl. emplastrum meloes vesicatorii, Edin. plaster of cantharides.

Emplastrum meloes vesicatorii composit. Edin. plaster of cantharides, compound.

Emplastrum oxidi plumbi semivitrei, Edin. emplastrum lithargyri, plaster of common litharge.

Emplastrum resinorum, Edin. emplastrum lithargyri cum resina, Lond. plaster, adhesive.

Emplastrum assafœtida, Edin. emplastrum gummosum, Lond. plaster of gum or assafœtida.

Emplastrum lithargyri compositum, Lond. plaster of litharge, compound.

Emplastrum saponis, Dubl. emplastrum saponaceum, Lond. Edin. plaster of soap.

Emplastrum thuris compositum, Lond. plaster of frankincense, compound.

Emplastrum hydrargyri, Edin. plaster of quicksilver.

Emplastrum ammoniaci cum hydrargyro, Lond. plaster of gum ammoniac with quicksilver.

Emplastrum lithargyri cum hydrargyro, Lond. plaster of litharge with quicksilver.

Emplastrum oxidi ferri rubri, Edin. plaster of red oxide of iron.

We shall close this article by observing, that the adult dose of the different preparations, and materials of which they are composed, will for the most part be found in the article MATERIA MEDICA.

Since writing the above we have received a copy of a specimen just printed, and limitedly circulated by the London College of Physicians, as the ground-work of a new Pharmacopœia which it is their intention to bring forward as soon as they may be able to avail themselves of the various hints and suggestions which it is probable will result from a circulation of their present pamphlet. As this is a work of high consequence to the medical world, and of curiosity to those who have not had an opportunity of seeing the specimen before us, and more especially as we are persuaded that the Royal College, with its usual liberality, will receive with thanks any important information upon the subject in question, from whatever quarter it may proceed; we shall endeavour as concisely as possible to sketch an outline of the valuable labours in which they are engaged, from the specimen before us: which we cannot better commence than in the words of the Committee, to whom the College has chiefly submitted the undertaking.

In the progression of human knowledge, pharmacy cannot remain stationary, and the College have accordingly accommodated it to existing circumstances, at suitable intervals, and thereby regulated and improved the practice of medicine in this country. Such a revision they have felt themselves called upon to make, at the present time, by the vast improvement in the several branches of science, with which pharmacy is more especially connected, since the year 1787, and they think it proper to state generally the principles upon which various alterations have been adopted in the present instance.

These alterations are referable to the several heads of nomenclature, weights and measures, arrangement, processes, the omission of former articles, and the introduction of new ones.

To each of these it will apply as a general observation, that practical application and convenience have been assumed as fundamental points, which the Committee have endeavoured constantly to keep in view.

1. *Nomenclature.* At the time of the publication of the last Pharmacopœia, modern chemistry was in its infancy, its language, (which professed to describe, and not merely to designate a substance by its name) was new in principle, and the application of it not generally received. Various terms, therefore, of that Pharmacopœia differ essentially from those which have since been established in the science, and it has been incumbent upon the Committee to consider in the present instance whether the nomenclature of chemistry might be still further and more minutely adopted. As far as arbitrary names (to which common consent has affixed precise ideas) go, and also in compounds consisting of two ingredients only, or where different proportions of the same constituent parts are to be expressed, it has been thought proper to receive those terms which general chemistry employs; but as a large proportion of pharmaceutical preparations consist, strictly speaking, of more complex combinations, which cannot be expressed correctly without periphrasis and inconvenience, and are therefore but ill suited to the purposes of prescription, the Committee have judged it sufficient to designate these, without attempting at the same time to describe their composition; and whether the name has been drawn from some circumstance of preparation, or quality, they have cautiously endeavoured to make such distinctions as may be least liable to error in the ordinary method of practice, and may not contradict the received chemical doctrines, or mislead in their application.

The names of vegetables have also been accommodated to the latest systems of botany, so that they may not hereafter contradict the terms of that science, or deceive the practitioner in his references thereto. Many names of medicinal plants were in the earlier periods of botany drawn from those of families to which modern system does not admit them to belong,* but have been retained in pharmacy, though wholly at

* *Cicuta. Helleborus albus.*

variance with the improved state of science. The Committee trust they have been able to remedy this inconvenience without very frequent violence to the names commonly employed. They have thought it most convenient, and fully sufficient, to express each article in general by a single word*, and have retained the former one wherever it accorded either with the generic or specific name of Linnæus, both of which, however, it has been necessary to employ, for the purpose of distinguishing between them, when more than one species is taken from the same genus†. There being some vegetable substances, the names of which are in a manner independent of botanical nomenclature‡, no alteration with respect to these seemed necessary, for in fact they are not at variance with modern science. Intending, moreover, that the pharmaceutic name shall, where a part of a plant is used, refer to that part only, they have transferred the term expressive of such part from the first column of the catalogue, in which it formerly stood, to the second.

2. *Weights and Measures.* From the great uncertainty of the customary mode of dividing by drops any quantities of liquids of less bulk than a drachm, and the increase of that uncertainty by the late introduction into some shops of measures applying to liquids of different densities, the bulk of a drop of water as a standard, the Committee have been led to consider the subject more particularly, and to adopt means for the removal of this uncertainty in the exhibition of many active remedies for the future. They have, for this purpose, adopted the graduated measure of the late Mr. Lane, which is founded upon an accurate division of the exchequer wine gallon down to the one-sixtieth part of a drachm, and which is equivalent to a drop of water. Of course it is their intention, that the common method of dropping liquids of different densities should be disused, and the measure received into the shops of apothecaries, a point upon which it will be necessary to place especial stress, in order that prescriptions may be accurately prepared. As the same Latin term has been employed to express the pint measure and the pound weight, they have extended the same resemblance to inferior measures, and have the more readily substituted *granum* for *gutta*, because the latter term implies that peculiar mode of division which they wish to deprecate.

3. *Arrangement.* On this head it is only necessary to observe, that the chapters have been arranged in what appeared to be a more natural and convenient order of the substances concerned than the former one.

4. *Processes.* Considerable alteration has been made in various processes, by which it is hoped they will be found more accommodated to general use. Expense in preparation ought not to be balanced against correctness and uniformity, and it is to be lamented that the profits and competition of trade should have induced a very extensive disposition to deviate from the directions of the Pharmacopœia. To this point, therefore, the Committee have looked with much attention, and, as far as they have thought themselves justified, they have endeavoured to make such deviation less an object to the operating chemist than heretofore; for this purpose they have not looked in their formulæ to that accuracy which would be necessary for chemical tests, but rather to the uniformity of the preparation, and its use as a medicine. The directions for manipulation are given generally, because they admit of some variety in their application in many instances, according to the scale on which they are prepared, and other circumstances; the Committee trust, however, that, if their directions be followed, the results will be in the same proportion uniform and correct, and that the well-educated apothecary will have no difficulty in understanding and applying them. Under this head, it is particularly incumbent upon the Committee to acknowledge the great advantage they have derived from the liberal communications of the Society of Apothecaries, with respect to the practice of their extensive concern, and also from many individuals engaged in chemical preparations upon a large scale.

5. *Omission of former Articles, and Introduction of new ones.* In the rejection of many substances of trifling importance or efficacy, of others which have appeared rather to belong to extemporaneous prescription, and of certain forms of medicine which have become obsolete in general practice, and also in the introduction of any new articles, the Committee have exercised their own judgment freely, and they trust with sufficient caution. They hope the College at large will approve of their having neglected to insert many substances which

* *Aconitum. Cascarilla.*

† *Rosa Gallica. Rosa canina.*

‡ *Arabicum gummi.*

individual practitioners have recommended and employed, where such have not received the sanction of more general experience. They conceive further, that a strict examination of its powers ought to precede the introduction of any article into the Pharmacopœia, and that the late appointment of a Committee of the College for this express purpose will hereafter appreciate the value of such recommendations by surer tests than those which have heretofore been deemed sufficient.

The proposed Materia Medica is as follows, in which it will be perceived that the vegetables are described in the second column from Wildenow's edition of the "Species Plantarum" of Linnæus; and the animals from Gmelin's "Systema Naturæ" of the same writer, excepting indeed in a very few instances. This table we cannot and ought not to abridge.

Absinthium	Artemisia Absinthium
Acetosa	Rumex Acetosa *Folium*
Acetosella	Oxalis Acetosella
Acetum	
Aconitum	Aconitum Napellus
Acidum sulphuricum	Acidum sulphuricum
Adeps	Sus Scrofa *Adeps*
Ærugo	Sub-Acetis Cupri
Allium	Allium sativum *Radix*
Aloe Barbadensis	Aloe elongata MURRAY, *Opusc. Botan.* *Succus spissata*
—— socotorina	Aloe spicata *Succus spissatus*
Althææ Folium —— Radix	Althæa officinalis
Alumen	Super-sulphas Aluminæ et Potassæ
Ammonia muriata	Murias Ammoniæ
Ammoniacum	*Plantæ adhuc incognitæ Gummi-resina*
Amygdala amara	Amygdalus communis. Var. γ
—— dulcis	Var. β *Nucleus*
Amylum	Triticum hybernum *Amylum*
Anethum	Anethum graveolens *Semen*
Angusturæ Cortex	*Arboris Americæ meridionalis adhuc incognitæ Cortex*
Anisum	Pimpinella Anisum *Semen*
Anthemis	Anthemis nobilis *Flos simplex*
Antimonium sulphuratum	Sulphuretum Antimonii
Arabicum Gummi	Acacia vera *Gummi*
Argentum	
Armoracia	Cochlearia Armoracia *Radix*
Arsenicum	Oxidum Arsenici album
Asarum	Asarum Europæum *Folium*
Assafœtida	Ferula Assafœtida *Gummi-resina*
Aurantium Hispalense	Citrus Aurantium (Hispalensis) *Bacca*
Aurantii Cortex	*Bacca Cortex exterior*
Balsamum Peruvianum	Myroxylon peruiferum *Balsamum*
—— Tolutanum	Toluifera Balsamum *Balsamum*
Barilla	Carbonas Sodæ impura
Belladonna	Atropa Belladonna *Folium*
Benzoin	Styrax Benzoin *Balsamum*
Bistorta	Polygonum Bistorta *Radix*
Borax	Sub-boras Sodæ
Cajuputi Oleum	Melaleuca Cajuputi *Oleum essentiale*
Calaminaris	Carbonas Zinci impura
Calamus	Acorus Calamus *Radix*
Cambogia	Stalagmitis Cambogioides *Gummi-resina*
Camphora	Laurus Camphora *Materia volatilis peculiaris*
Canella	Canella alba *Cortex*
Capsicum	Capsicum annuum *Capsula*
Carbo Ligni	
Cardamine	Cardamine pratensis *Flos.*
Cardamomum	Alpinia repens SMITH, in *Act. Soc. Lin.* *Semen*

Carum	Carum Carui *Semen*	
Caryophyllus	Eugenia caryophyllata *Flos nondum expansus siccatus*	
Caryophylli Oleum	*Ejus oleum essentiale*	
Cascarilla	Croton Cascarilla *Cortex*	
Cassia Fistula	Cassia Fistula *Lomenti pulpa*	
Castoreum Rossicum	Castor Fiber *Materia peculiaris*	
Catechu	Acacia Catechu *Extractum*	
Centaurium	Chironia Centaurium *Cacumen*	
Cera alba —— flava	Apis mellifica *Cera*	
Cerussa	Oxidum Plumbi album	
Cinchonæ Cortex	Cinchona lancifolia *Cortex*	
—— flavus	Cinchona cordifolia *Cortex*	Mutis.
—— ruber	Cinchona oblongifolia *Cortex*	
Cinnamomi Cortex	Laurus Cinnamomum *Cortex*	
—— Oleum	*Ejus oleum essentiale*	
Coccus	Coccus Cacti	
Colchicum	Colchicum autumnale *Radix recens*	
Colocynthis	Cucumis Colocynthis *Pomi pulpa*	
Colombo Radix	*Plantæ adhuc incognitæ Radix*	
Conium	Conium maculatum	
Contrajerva	Dorstenia Contrajerva *Radix*	
Copaiba	Copaifera officinalis *Resina liquida*	
Coriandrum	Coriandrum sativum *Semen*	
Cornu	Cervus Elaphus *Cornu*	
Creta	Carbonas Calcis	
Crocus Anglicus	Crocus sativus *Stigma*	
Cuminum	Cuminum Cyminum *Semen*	
Cuprum		
Cuprum sulphuricum	Sulphas Cupri	

Cydonia	Pyrus Cydonia *Semen*
Dauci Radix	Daucus Carota (hortensis) *Radix*
—— Semen	Daucus Carota (spontanea) *Semen*
Digitalis	Digitalis purpurea *Folium*
Dolichos	Dolichos pruriens *Leguminis pubes*
Dulcamara	Solanum Dulcamara *Caulis*
Elaterium	Momordica Elaterium *Pomum recens*
Elemi	Amyris Elemifera. *Resina*
Ferrum	
Ficus	Ficus Carica *Fructus præparatus*
Filix Mas	Aspidium Filix Mas. *Radix*
Fœniculum	Anethum Fœniculum *Semen*
Fucus	Fucus vesiculosus
Galbanum	Bubon Galbanum *Gummi-resina*
Galla	Cynips Quercus folii *Nidus*
Gentiana	Gentiana lutea *Radix*
Glycyrrhiza	Glycyrrhiza glabra *Radix*
Granatum	Punica Granatum *Pomi Cortex*
Guaiaci Gummi-resina. —— Lignum	Guaiacum officinale
Hæmatoxylon	Hæmatoxylon Campechianum. *Lignum*
Helleborus fœtidus	Helleborus fœtidus *Folium*
Helleborus niger	Helleborus niger *Radix*
Hordeum	Hordeum distichon *Semen epidermide nudatum*
Humulus	Humulus Lupulus *Strobilus siccatus*
Hyoscyamus	Hyoscyamus niger
Jalapa	Convolvulus Jalapa *Radix*

Ipecacuanha	Callicocca Ipecacuanha BROTERO, *Act. Soc. Lin.* *Radix.*
Juniperi Bacca ——— Cacumen	Juniperus communis
Kino	*Arboris adhuc incognitæ Africanæ Gummi-resina*
Lapis calcareous	Carbonas Calcis
Lavandula	Lavandula Spica *Flos.*
Lauri Bacca —— Folium	Laurus nobilis
Lichen	Lichen Islandicus
Limon	Citrus Medica *Bacca*
Limonis Cortex	*Ejus cortex exterior*
Linum catharticum	Linum catharticum
——— usitatissimum	Linum usitatissimum *Semen.*
Lithargyrus	Oxidum Plumbi semi-vitreum
Magnesia sulphurica	Sulphas Magnesiæ
Malva	Malva sylvestris
Manna	Fraxinus Ornus *Succus concretus*
Marrubium	Marrubium vulgare
Mastiche	Pistacia Lentiscus *Resina*
Mel.	Apis mellifica *Mel.*
Mentha piperita	Mentha piperitha Var. α. SMITH, in *Act. Soc. Lin.*
——— viridis	Mentha viridis Var. α. SMITH, in *Act. Soc. Lin.*
Menyanthes	Menyanthes trifoliata
Mezereum	Daphne Mezereum *Radicis cortex*
Morus	Morus nigra *Bacca*
Moschus	Moschus moschiferus *Materia peculiaris*
Myristica	Myristica moschata *Nucleus*
Myrrha	*Arboris adhuc incognitæ Gummi-resina*
Nitrum	Nitras Potassæ
Olibanum	Juniperus Lycia *Gummi-resina*
Olivæ Oleum	Olea Europæa. *Drupæ Oleum expressum*
Opium	Papaver somniferum. *Capsulæ immaturæ succus concretus Orientalis.*
Opoponax	Pastinaca Opoponax *Gummi-resina*
Origanum	Origanum vulgare
Ovum	Phasianus Gallus *Ovum*
Papaver Rhœas	Papaver Rhœas *Corolla*
——— somniferum	Papaver somniferum *Capsula matura*
Petroleum	
Pimenta	Myrtus Pimenta *Bacca*
Piper longum	Piper longum *Fructus immaturus siccatus*
—— nigrum	Piper nigrum *Bacca immatura*
Pix Burgundica	Pinus Abies *Resina præparata*
— liquida	Pinus sylvestris *Resina præparata*
Porrum	Allium Porrum *Radix*
Potassa impura	Carbonas Potassæ impura
Pterocarpus	Pterocarpus Santalinus *Lignum*
Pulegium	Mentha Pulegium
Pyrethrum	Anthemis Pyrethrum *Radix*
Quassia	Quassia excelsa *Lignum*
Quercus	Quercus pedunculata *Cortex*
Resina	Pinus sylvestris *Resina*
Rhamnus	Rhamnus catharticus *Bacca*
Rheum	Rheum palmatum *Radix*
Ricini Oleum	Ricinus communis *Seminis Oleum fixum*
Rosa canina	Rosa canina *Bacca*
—— centifolia	Rosa centifolia *Corolla*
—— Gallica	Rosa Gallica *Corolla*
Rosmarinus	Rosmarinus officinalis *Cacumen*
Rubia	Rubia Tinctorum *Radix*

Ruta	Ruta graveolens
Sabina	Juniperus Sabina *Folium*
Saccharum ——— purificatum	Saccharum officinale *Succus expressus præparatus*
Sagapenum	*Plantæ adhuc incognitæ Gummi-resina*
Salix	Salix Caprea *Cortex*
Sambucus	Sambucus nigra *Flos.*
Sarsaparilla	Smilax Sarsaparilla *Radix*
Sassafras Lignum ——— Radix	Laurus Sassafras
Scammonia	Convolvulus Scammonia *Gummi-resina*
Senega	Polygala Senega *Radix*
Senna	Cassia Senna *Folium*
Serpentaria	Aristolochia Serpentaria *Radix*
Sevum	Ovis Aries *Sevum*
Simarouba	Quassia Simarouba *Cortex*
Sinapis	Sinapis nigra *Semen*
Soda muriata	Murias Sodæ
Spartium	Spartium scoparium *Cacumen*
Spermaceti	Physeter macrocephalus *Materia peculiaris*
Spigelia	Spigelia Marilandica *Radix*
Spiritus rectificatus Hujus pondus specificum est ad pondus Aquæ distillatæ ut 835 ad 1000.	
Spiritus tenuior Hujus pondus specificum est ad pondus Aquæ distillatæ ut 950 ad 1000.	
Spongia	Spongia officinalis
Squilla	Ornithogalum Squilla. Sims, *Bot. Mag.* *Radix*
Stannum	Stanni Limatura
Staphisagria	Delphinium Staphisagria *Semen*

Styrax	Styrax officinale *Balsamum*
Succinum	
Sulphur	
——— sublimatum	
Tabacum Virginianum	Nicotiana Tabacum *Folium siccatum*
Tamarindus	Tamarindus Indica *Leguminis Pulpa*
Taraxacum	Leontodon Taraxacum *Radix*
Tartarum	Super-Tartris Potassæ impura
Tartarum purificatum	Super-Tartris Potassæ
Terebinthina Canadensis	Pinus Balsamea *Resina liquida*
——— Chia.	Pistacia Terebinthus *Resina liquida*
——— vulgaris	Pinus sylvestris *Resina*
Testa	Ostrea edulis *Testa*
Thus	Pinus Abies *Resina concreta*
Tormentilla	Tormentilla officinalis Smith, in *Flor. Brit.* *Radix*
Toxicodendron	Rhus Toxicodendron *Folium*
Tragacantha	Astragalus Tragacantha *Gummi*
Tussilago	Tussilago Farfara
Valeriana	Valeriana officinalis Var. sylvestris *Radix*
Veratrum	Veratrum album *Radix*
Viola	Viola odorata *Flos recens*
Vesicatorius	Meloe Vesicatorius
Vinum	Vinum album Hispanicum *Sherry* dictum
Ulmus	Ulmus campestris *Liber*
Uva passa	Vitis vinifera *Bacca præparata*
Uva Ursi	Arbutus Uva Ursi *Folium*
Zincum	
Zingiber	Zingiber officinale Roscoe, in *Act. Soc. Lin.* *Radix*

The preparations and compounds are exhibited under the following heads:

Acida	Tincturæ
Alkalina	Ætherea
Ferrea	Vina
Sales	Aceta
Sulphurea	Mellita
Metallica	Syrupi
Vegetabilia	Confectiones
Olea Expressa	Pulveres
Olea Distillata	Pilulæ
Aquæ Distillatæ	Partium Animalium præparatio
Decocta	Emplastra
Infusa	Cerata
Mucilagines	Unguenta
Extracta	Linimenta
Misturæ	Cataplasmata.
Spiritus	

Upon these divisions the limits to which we are confined prevent us from making more than a few observations.

Among the acids we perceive a form for the citric, now first introduced into the list, which will be found a useful and elegant medicine; we have a new form for the nitric, and the flores benzoës assume the name of acidum benzoicum.

In the alkalines we meet with no great difference, except in the change of names, which, for the most part, are shortened from those of the Edinburgh Pharmacopœia.

The same general observation may apply to the earths and salts, which, under the existing Pharmacopœia, form one common chapter with the two preceding divisions. The chapter sales employs the term soda instead of that of natron.

The sulphurea of the proposed Pharmacopœia is nearly a transcript of the preparata e sulphure of that now in use.

Among the metallica we perceive the pulvis antimonialis ordered to be prepared with half the quantity of sulphurated antimony to that of gross antimony, as under the present form. A useful and well-known preparation of arsenic is introduced under the name of liquor arsenicalis. Copper furnishes two preparations, cuprum ammoniatum and liquor cupri ammoniati; and iron several additional forms.

Among the distilled waters, the aqua anethi is banished, and the aqua carui introduced in its stead.

The addition to the chapter of decoctions is numerous, and consists chiefly in a form of this kind for the dulcamara, lichen, senega, and veratrum.

To the infusions there is also a very numerous addition: angustura, cloves, cascarilla, cinchona, columbo, quassia, rhubarb, simarouba, tobacco, digitalis, tar, horseradish, each becomes a separate subject of this mode of preparation.

Among the mucilages, that of tragacanth is omitted.

The extracts afford us new preparations in the hop (humulus lupulus) poppy, sarsaparilla, dandelion (taraxacum), and hemlock.

The mixtures gives us a new form for gum guaiacum.

The spirits revive the old spiritus anisi, and spiritus raphani, the latter under the newer name of spiritus armoraciæ compositus.

The chapter of tinctures, provides a new form for capsicum, digitalis, humulus, hyoscyamus, kino.

The aceta give us a form for the colchicum.

The syrupi provide a form for the lemon, and order the syrupus papaveris somniferi to be prepared from its extract.

The term confectiones is intended to embrace equally electuaries, confections, and conserves: from this chapter several of the existing forms are banished.

The list of pulveres is also considerably diminished, chiefly by a rejection of several of the cretaceous preparations.

Among the pilulæ we now meet with a gamboge pill: the opium pill is banished.

The list of emplastra is diminished in a few forms, and enriched by a new Preparation entitled emplastrum thuris cum opio,

The cerata are increased by a ceratum sabinæ, and C. vesicatorii.

The unguenta are much diminished; several of those, indeed, in the existing Pharmacopœia being transferred under a different preparation to the chapter of cerata: while as new articles we have an U. hydrargyri nitrici, U. hydrargyri nitrico-oxydati, and U. veratis.

The liniments give us as a new preparation, a lin. æruginis.

The cataplasms offer us a new form for one prepared from meal and yeast, under the title of C. effervescens.

PHARMACOLITE, in mineralogy, is of a snow-white colour, and it occurs in small crystals, though sometimes in other forms. Internally it is glistening, with a silky lustre. Its fracture is radiated or fibrous: it also presents large and small granular, distinct concretions. The crystal-

lized varieties are translucent; it is very tender, and easily frangible; it is soluble in nitric acid, without effervescence; it consists of

Arsenic acid	46.5
Lime	23.
Oxide of cobalt	0.5
Silex and alumina	6.
Water	22.5
	98.5
Loss	1.5
	100.0

This mineral is found in veins of granite in Germany and France.

PHARNACEUM, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; corolla none; capsule three-celled, many-seeded. There are fourteen species, chiefly natives of the Cape of Good Hope.

PHARUS, in botany, a genus of the Monoecia Hexandria class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx glume two-valved, one-flowered: male, corolla glume two-valved: female, corolla glume one-valved, long, involving; seed one. There are three species, natives of the East Indies.

PHASCUM, in botany, a genus of the Cryptogamia Musci class and order. Generic character: capsule ovate, veiled, sub-sessile, or on a short bristle, closed on every side, sometimes with the rudiment of a lid, never opening: males, sub-discoid, terminating, or gemmaceous axillary.

PHASEOLUS, in botany, *kidney bean*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: keel with the stamens and styles spirally twisted. There are twenty-one species. The varieties of the kidney bean are very numerous: the P. coccineus, scarlet kidney bean, is by some considered as a distinct species; its twining stalks, if properly supported, will rise to the height of twelve or fourteen feet; the leaves are smaller than those of the common garden bean; the flowers grow in large spikes of a deep scarlet colour; the pods are large and rough; they are more esteemed for the table, by many people, than the others.

PHASES, in astronomy, the several appearances or quantities of illumination of the Moon, Venus, Mercury, and the other planets; or the several manners wherein they appear illuminated by the Sun. With regard to the Moon, these phases are very observable with the naked eye; by which she sometimes increases, and sometimes wanes; is now bent into horns, and again appears as half a circle. By means of a good telescope, the like phases may be observed in Venus and Mars. Copernicus, before it was possible to ascertain the fact, by means of glasses, foretold that it would, at some period or other, be ascertained, that Venus underwent all the changes to which the Moon was subject. Galileo was the first person who, by actual observation, confirmed the truth of Copernicus's theory.

PHASIANUS, the *pheasant*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill short, strong, and convex; head covered in some degree with carunculated flesh; legs generally with spurs. There are ten species.

P. gallus, or the wild pheasant, inhabits the forests of India, and has been seen, indeed, by navigators in almost all the Indian and South Sea islands. This is the unquestionable origin of all the domestic varieties throughout Europe, of which we shall notice the following.

P. gallus, or the dunghill cock. The most interesting animal under this variety, is the game cock, which is found in greater perfection of vigour and courage in England, than in any other country; and the irascibility and jealousy of which has, in almost all ages, occasioned it to be employed in the sanguinary diversion of cock-fighting. This practice is carried to a great extent, even among the mild inhabitants of China and India, whose manners, or principles, might be conceived in the highest state of repugnance to it. The polished civilization of the Athenians did not prevent their engaging in it with considerable ardour, and the Romans encouraged it with all that fondness which might be expected from a nation established by rapine, and as it were educated in blood. From them it was introduced into England, where it has occasionally been patronized by monarchs, and is still indulged in both by lords and plebeians with considerable frequency, though, probably, not to such a degree as in some former periods. The appearance of this animal, when under the agitation of strong feeling, is highly interesting, indicating boldness, freedom, and energy, of a very superior character; and the beauty of his plumage,

and gracefulness of his movements, combine strongly to heighten the effect. The female is remarkable for great fecundity, and for the most exquisite parental fondness and sensibilities; the poets of almost every age and nation having introduced it as the most expressive image of maternal duty and tenderness. It is finely observed, by the great French naturalist, that "dull and tasteless as the business of incubation may be thought by us, nature may have made it a state of extraordinary joy, connecting, probably, sensations of delight with whatever relates to the continuance of her offspring." In some countries, and particularly in Egypt, chickens are produced from eggs without the assistance of the parent bird. The eggs are enclosed in ovens heated with extreme care and precision, and turned at certain intervals, and thus hundreds, and even thousands, are annually produced in one establishment; but chickens, thus produced, are stated to be rarely so vigorous as those hatched in the natural mode. See Aves, Plate XII. fig. 1.

P. colchicus, or the common pheasant. These birds are found in almost every territory of the old continent; but are not to be met with in America. Their wings, from their shortness, are ill calculated to sustain a long flight. They resemble the partridge in breeding on the ground, and lay from twelve to fifteen eggs. In many parts of this kingdom they have been introduced with great success, exhibiting an interesting and beautiful object to the admirer of nature, and furnishing variety to the pursuits of the sportsman, as well as to the luxuries of the table. Pheasants prefer low woods bordering upon valleys, are extremely shy, and never associate but in the spring. The hen pheasant has been occasionally discovered with the feathers almost universally peculiar to the male; and, indeed, this circumstance takes place in several other genera of birds. The crowing of the pheasant is very similar to that of the former species, but not so loud or so distinct. There are many varieties of the pheasant tribe kept in the aviaries of the curious in this kingdom, exhibiting the most admirable plumage, but not sufficiently hardy to endure the rigours of winter in this climate, where the P. colchicus alone has become nationalized. See Aves, Plate XII. fig. 2.

PHEASANT. See PHASIANUS.

PHELLANDRIUM, in botany, *water hemlock*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: florets of the disk smaller; fruit ovate, even, crowned with the perianth and pistil. There are two species, viz. P. aquaticum, common water hemlock, and P. mutellina: the former is a native of most parts of Europe: Linnæus informs us, that the horses in Sweden, by eating this plant, are seized with a kind of palsy; this effect is not to be ascribed to the plant, but to a coleopterous insect breeding in the stalks: in the winter, the roots and stem, dissected by the influence of the weather, afford a curious skeleton or net-work.

PHILADELPHUS, in botany, *syringa*, a genus of the Icosandria Monogynia class and order. Natural order of Hesperideæ. Myrti, Jussieu. Essential character: calyx four or five-parted, superior; petals four or five; capsule four or five-celled, many-seeded. There are four species, of which P. coronarius, common or white syringa, is a shrub that sends up a great number of slender stalks from the root, seven or eight feet in height, putting forth several short branches from their side; leaves ovate, lanceolate, three inches long, and two broad in the middle, terminating in acute points, with several indentures on their edges; they have both the taste and scent of fresh cucumbers; the primary flower is five-cleft in the calyx, corolla, pistil, and capsule; the rest are four-cleft. It is a native of the South of Europe.

PHILLYREA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: calyx four-toothed; corolla four-cleft; berry two-celled; seeds solitary. There are three species, which are distinguished by the form and indentations of their leaves; they are shrubs, and natives of the southern countries of Europe; they are evergreens, and sufficiently hardy to thrive in the open air, being rarely injured, except in very severe winters, which causes their leaves to fall, and kills some of the weaker branches; these are repaired by new shoots the following summer; there are few evergreens which are hardier than the phillyrea, or that deserve more to be cultivated for pleasure.

PHILOLOGY, a science, or rather assemblage of several sciences, consisting of grammar, rhetoric, poetry, antiquities, history, and criticism. Philology is a kind of universal literature, conversant about all the sciences, their rise, progress, authors,

&c. It makes what the French call the *belles lettres*. In the universities it is called humanities. Anciently, philology was only a part of grammar.

PHILOSOPHER, a person versed in philosophy; or one who makes profession of, or applies himself to, the study of nature and morality. See PHILOSOPHY.

PHILOSOPHER'S *stone*, the greatest object of alchymy, is a long sought for prepation, which, when found, is to convert all the true mercurial part of metal into pure gold, better than any that is dug out of the mines, or perfected by the refiner's art.

PHILOSOPHY, *mental*. 1. That science which teaches us the laws of our mental frame, which shews us the origin of our various modes and habits of thought and feeling, how they operate upon one another, and how they are cultivated or repressed, is mental philosophy, or the philosophy of the human mind. The well directed study of it calls into action and improves the highest intellectual faculties; and while it employs the powers of the mind, it suggests the best means for their culture, and the best mode of their direction. It enables us to trace the intricacies of our own hearts, and points out the proper discipline for their correction. It discovers to us the real excellencies of the mind, and guides us in our efforts for the attainment of them. To success in forming the moral and mental character of others, it is more or less essential; for it discloses the nature of our influence over their minds, and the best mode of exercising it so as to bring their various faculties into the best adjusted and most perfect state. Pursued with proper views, and in a proper manner, it lays the best foundation for the highest degrees of intellectual, moral, and religious improvement.—"There are difficulties," to use the words of the great Hartley, "both in the word of God and in his works; and these difficulties are sometimes so magnified as to lead to scepticism, infidelity, or atheism. Now the contemplation of our own frame and constitution appears to me to have a peculiar tendency to lessen these difficulties attending natural and revealed religion, and to improve their evidences, as well as to concur with them in their determination of man's duty and expectations."

2. The best ground-work for the pursuit of mental science is an accurate judgment, a discriminating penetrating intellect, and a habit of correct and cautious reasoning; and therefore the best preparatory culture of mind is the study of the various branches of the mathematics and of natural philosophy. But habits of reflection and good sense are all which are essential to the beneficial pursuit of mental science; and with these, it will in all cases lead to results highly important to individual welfare and usefulness.—The young in particular will be led by an acquaintance with the practical laws of the mind, to perceive how their present conduct affects their future character and happiness; to perceive the importance of avoiding a frivolous employment of their time, without any end beyond mere amusement; to perceive the impossibility of indulging in vicious gratifications, without lessening their means of happiness, and checking their progress towards excellence. They will learn how habits are formed, almost imperceptibly, and when long exercised how exceedingly difficult it is to eradicate them; they will learn to consider the formation of habits as requiring, therefore, their utmost circumspection. They will be enabled to discern what habits of thought and feeling are baneful, what useful; what means of happiness should be regarded as of primary value, what should be regarded as secondary only.—In short, there can be no hesitation in affirming that next to the immediate pursuits of religion, to which the laws of the mind direct, a judicious acquaintance with those laws is the most important means for the right employment of that period of life on which the happiness of our existence in a great measure depends.

3. We cannot even attempt to give our readers a complete system of this important science; however brief it might be made, if it were as comprehensive as the subject requires it would occupy too great a portion of this work: what we wish to aim at is, to give such a view of the leading laws of our mental frame as may direct the thoughts of the inquirer into a right channel, and serve as a foundation for the results of attentive reflection, which reading may assist in gaining, but can seldom impart.

OF THE PRIMARY FACULTIES OF THE MIND.

4. That, whatever it be, which thinks, and feels, and wills, is called mind: that part of the human being which thinks, and feels, and wills, is called the human mind.

5. We observe without us and within us numerous phenomena; the object of philosophy is to deduce from them certain gene-

ral laws agreeable to which they are produced, and then to employ those laws in the explanation of other phenomena. Mental philosophy pursues the same method which has been so successfully adopted in natural philosophy; and as in physics similar phenomena are referred to the operation of some one cause or power, so in mental science those phenomena which have all one common feature are referred to some faculty or property of the mind, by whose operation these phenomena are supposed to be produced. What those mental or physical powers are, philosophy does not profess to explain.

6. If we hold a luminous body before the eye it produces some change in the state of that organ, and this produces in the mind a feeling; this feeling is called a sensation. This name is also given to all those other feelings which are produced in a similar way, viz. owing to a change in the organs of sense, whatever be the cause by which the change is produced.—The general fact or law is, that sensations are produced by what affects the organs of sense. Now to account for this fact, we infer that the mind is possessed of a power or capacity which we call sensation, or, better to avoid ambiguity, the sensitive power. This then is that power or capacity of the mind by whose operation it receives sensations from things which affect the organs of sense.

7. We know as a matter of fact, that though sensations cease soon after the exciting object is withdrawn, yet if they have been produced sufficiently often and vividly, the causes of feelings similar in kind remain in the mind, and those similar feelings can recur when no change is produced in the organs of sense. These are called ideas; they are the relicts of sensations.—Such is the general law or fact. The operation or act of retaining relicts of sensations, may with the strictest propriety be termed retention; and to account for it, we infer that the mind possesses a power or capacity, which we may call the retentive power. This then is that power or capacity of the mind, by which it retains relicts of sensations.

8. Again; it is an indisputable fact, that these ideas or relicts of sensations, do not remain single in the mind, but become connected with one another, so that the recurrence of one, or of its corresponding sensation, will bring on another; and that in certain cases they become so blended together, that the parts can scarcely be distinguished. Thus the word orange either pronounced or thought of, will bring the idea of the appearance of an orange. Again, the idea of the word house is accompanied by a certain feeling which is altogether different from that which accompanies the idea of the word ship: if we think about it a little, we usually have the idea of a particular house recalled; this is a simple idea (or idea of sensation or conception) connected with other ideas, but not combined with them; but, in general, if the word occurs without the mind dwelling upon it, we may perceive an indistinct feeling, which is composed of a variety of simple ideas, received from a variety of those objects to which we give the name house. That the feeling is thus composed we have a full right to assert, on an attentive consideration of the customary processes of the mind.—Simple ideas may then be connected with other ideas; or they may blend and coalesce with other ideas, so as to form new ones, which are called compound or complex ideas. The general fact is, that connexions and compositions take place among our ideas; and when thus connected or compounded, we say that they are associated together, and the connected or compounded group we call an association. To account for the formation of associations, we infer that the mind possesses a power or capacity of connecting or combining ideas, which may be called the associative power. This then is that power or capacity of the mind by which it connects and compounds ideas.

9. Once more; it is obvious that without any external excitement of the nerves by which muscular motion is produced, the mind can produce such motion; in other words, that state of the motory nerves by which muscular motion is effected, can be produced by the mind. We do not here inquire how the mind learns to use its influence over the motory nerves, but state the fact, that muscular motion can be produced by the mind without external excitement. To account for this we infer that the mind possesses a power or capacity of influencing the motory nerves so as to produce muscular motion, which may be called the motive power.—We have no name appropriate to those states of mind which produce the changes in the motory nerves requisite for muscular motion; and we are therefore so far free from a difficulty which has accompanied us when speaking of sensations and ideas: these terms, as they are generally used, imply that the consciousness of the mind is excited. But it appears an almost

indisputable fact, that the mental organs, whatever they be, by whose action the consciousness is excited, often are in a state of activity without such excitement of the consciousness; in other words, that those changes which when accompanied with consciousness are termed sensations and ideas, may take place, and produce their appropriate effect in the mental system, without exciting the conscious or percipient principle. In order to enter into the consideration of this important fact, it will be necessary to consider somewhat more explicitly in what manner we employ the term mind, and to introduce some less customary terms in order to avoid ambiguity.

10. In the philosophical sense of the term mind, it seems to belong exclusively to the conscious or percipient principle whatever that be; but in common language we certainly employ it differently: *e. g.* no one hesitates in saying, " such a man has an extensive store of knowledge in his mind;" but no one supposes that at any one time a man perceives, that is, is conscious of, all the parts of that knowledge: in the same manner no one would hesitate in saying, " such a person has a great fund of valuable reflections for the conduct of life stored up in his mind, which he can produce whenever circumstances call for them;" but no one supposes that those reflections are always in the view of his mind, that is, that he is always conscious of them, that he always perceives them. All that can be meant in such cases is, that the causes of his ideas (that is of his thoughts and feelings) remain in the mind ready for excitement when they produce ideas.—Hence then the mind, in the common acceptation of the term, in which we use it, consists of two parts, the conscious or percipient principle, and the organized substance, which furnishes to the former the objects of its consciousness or percipiency. What the conscious or percipient principle is, is probably known to him only who formed it: we may believe consciousness or percipiency to be a property which is the necessary result of, or added to, a certain organized system of matter; or we may believe it to be a property of some substance essentially different from matter; and we apprehend it is not of much consequence which opinion is adopted: but it seems indisputable, that in the present state of knowledge, we cannot obtain, on either side, more than a bare preponderance of probabilities.

11. That organized substance, which, without any further medium, furnishes to the conscious or percipient principle the objects of consciousness or percipiency, may be called the sensorium. The parts of which the sensorium is composed, by whose motions or other changes, without any further medium, consciousness is excited, may be called the mental organs. By the mind, we understand the whole together, the conscious or percipient principle together with the sensorium; leaving it undecided, whether consciousness is a property of organized matter, or belongs to a substance essentially different from matter, and also, whether the sensorium be or be not the medullary substance of the brain. (See SENSATION.) Hartley, as is well known, adopts the affirmative in the latter case; and he supposes that the changes of the sensorium which affect the consciousness are vibrations of the medullary substance (see VIBRATION); we consider this hypothesis as a clog upon, at least, the adoption of his grand system of association, and should prefer the more general term, motions, if we professed to decide respecting the nature of the sensorium; as we do not, we shall employ the still more general term changes, since the term affections is already appropriated.—The changes in the sensorium, or mental organs, which may excite the consciousness, may be called sensorial changes. Of these some are produced by the impression of external objects upon the organs of sense; these may be called sensible changes: others, as we know by their effects, are producible without the presence of external objects; these may be called ideal changes, and are the relicts of sensible changes; a third class are those which are followed by muscular action, and may be termed motory changes. Each of these classes of sensorial changes may take place without consciousness, as we shall endeavour to show in the next paragraph. When sensible changes are accompanied with consciousness, they are called sensations; when ideal changes are accompanied with consciousness, they are called ideas; and as sensible and ideal changes are principally important to us when accompanied with consciousness, and it seldom is necessary to distinguish between those which do and those which do not excite it, we shall not usually depart from the customary nomenclature. We have no term appropriated to denote motory changes accompanied with consciousness: this deficiency probably arises from the circumstance, that muscular action is so much an

object of the senses, that by association it is referred to the moving muscle, and not to the intermediate fibrous motions and sensorial changes; thus while writing, all the motion seems to be in the fingers and in the fingers alone, though even the minutest motion, except that which is produced by some external stimulus upon the motory nerve, implies motory changes of the sensorium, and should, scientifically speaking, be referred to the sensorium, or mind.

12. To show that sensible changes are not necessarily accompanied with consciousness, we observe, that the diminution of consciousness can be traced in its various stages, from the state of active attention, to cases where we have no reason to believe that consciousness is excited, where yet we have abundant reason to believe that there were sensible changes; because those effects are produced, which we know are produced by sensations (that is, by sensible changes of which we are conscious), and, as far as we know, in no other way. We cannot, consistently with our requisite limits, advance so many facts as may appear to some to be necessary to prove our statements, but the following will at least illustrate them.—Persons much accustomed to employ notes in singing, sometimes feel so deeply interested in the thoughts and feelings excited by the words they are singing, that, though the notes continue to regulate their tones of voice, the sensible changes are altogether unnoticed by them, they do not excite the consciousness. Again, many who have been long accustomed to perform upon a musical instrument, and can play with ease at first sight, while playing a piece of music which they have not seen before, can converse and carry on a train of reasoning, and yet play correctly: the appropriate sensible changes must in such cases be produced; for otherwise the proper motions of the fingers could not; but they are not accompanied with consciousness; as soon as they are, attention to the conversation, or train of reasoning, is interrupted. In the same manner, persons accustomed to read aloud, can continue to read aloud, even what they never read before, with at least correctness, and at the same time have their thoughts closely employed on other objects. The following case, stated by Dr. Percival, will by most be admitted as a strong corroboration of our principles. "Several years ago the Countess of ——— fell into an apoplexy about seven o'clock in the morning: among other stimulating applications, I directed a feather, dipped in hartshorn, to be frequently introduced into her nostrils. Her ladyship, when in health, was much addicted to the taking of snuff, and the present irritation of the olfactory nerves produced a junction of the fore-finger and thumb of the right-hand, the elevation of them to the nose, and the action of snuffing in the nostrils. When the snuffing ceased, the hand and arm dropped down in a torpid state. A fresh application of the stimulus renewed these successive efforts; and I was witness to their repetition till the hartshorn lost its power of irritation, probably by destroying the sensibility of the olfactory nerves. The Countess recovered from the fit about six o'clock in the evening; but though it was neither long nor severe, her memory never afterwards furnished the least trace of consciousness during its continuance." Now here the impressions produced by the hartshorn on the external organ, produced (by means of the nerves) sensible changes; and these, either through the medium of ideal changes, or, more probably, directly, produced motory changes, which (by means of the nerves) produced muscular action; and the whole without exciting consciousness. The gradual diminution of attention to, or the consciousness of, external objects of sensation, (the beat of a clock for instance), when the mind is becoming closely engaged upon some object of reflection, must be obvious to every one who thinks on what passes within him; and it cannot be requisite to enlarge on that point.—Those who admit what we have stated respecting sensible changes, will feel little hesitation in admitting the same positions respecting ideal changes; because the latter are merely relicts of the former. Besides, there is another point of agreement. Sensible changes are produced without any effort of the mind, without any volition; so also are ideal changes. These latter, when not interrupted by sensations, follow one another in a train, without an effort, and often contrary to effort, regulated by the modes of connexion to which the individual is most prone. We believe that the position advanced respecting sensible changes, at the beginning of this paragraph, is equally applicable to ideal changes, *mutatis mutandis.* We shall give only one instance of that case in which consciousness entirely disappears, where yet we are certain, that there must have been ideal changes. Every one who

can add up a column of figures, knows the nature of the operation, because it is learnt after the memory has acquired considerable power. The sum of two or three figures is first ascertained: the ideal change of that sum must of course be in the mind, and with that sum is combined the next figure, which forms a new sum, and so on. Now then there is the act of adding a number, the ideal change of which is in the mind, to another number of which there is a sensible change, and there is the ideal change of the sum, and so on, continually recurring: this we perceive when we are trying to add up slowly. But persons who are very familiar with such additions, will tell the result or final sum, apparently without an effort, apparently without the intervention of the mind, and certainly without any consciousness of the operations and ideal changes which must have passed in the mind before the result could have been obtained. It will not unfrequently be found, that persons very much habituated to these operations, can add up much more correctly while they leave themselves unconscious of the operations and ideal changes, than when they are conscious of them: and, what appears to us to settle the point, as far as consciousness is concerned, persons who by constant custom have become familiar with all possible combinations of small numbers, can go through a series of additions, and at the same time closely engage the attention upon another object; for instance, can dictate one or more letters.—As to motory changes, the fact is so obvious, that muscular actions, which must have their origin in the mind, as being regulated by impressions upon the external organs of sense, go on in long succession, and with frequent variation, while at the same time the attention is fully occupied by some object of thought, that we should be ready to suppose nothing but opposition to a pre-formed hypothesis, could lead a person to doubt whether in such cases the muscular action excited the consciousness. Such an immense variety of muscular actions are continually taking place, in cases in which volition was once concerned, without in any way whatever attracting the notice of the mind, and this is so obvious a fact, and so satisfactorily accounted for by Hartley, that however plausible the counter-considerations of the great northern philosopher, Dugald Stewart, (see Elements, chap. ii.) we cannot suppose that they can gain admission where the principle of association is thoroughly understood.

13. If this distinction between sensible and ideal changes, and sensations and ideas, be just; or rather, if the existence of sensorial changes, without consciousness, be admitted, (and we more and more feel satisfied that it is a fact, and if so, a very important one in our mental frame), then the four preceding faculties, or capacities of the mind, are to be referred to the sensorium, and are, in reality, the properties or powers of the mental organs. We feel disposed to admit, that the sensorium is the medullary substance of the brain; but we beg our readers to bear in mind, that what we have advanced is entirely independent of this opinion, and that indeed it is rather clogged by it. We use the terms sensorium and mental organs, because, in our opinion, they tend to give greater distinctness to our reflections on what passes within us; but it is with no view to decide whether they are material or immaterial.—Consciousness, or the percipient faculty, we consider as a distinct faculty from those already mentioned; it is the faculty or capacity by which the mind is affected by sensoriall changes, whether sensible, ideal, or motory. Consciousness is in fact the notice of the mind itself; and the term is applied to that state with which every sensorial change which excites the notice of the mind is attended.—When the consciousness is continued, either on a particular object, or on a particular succession of objects, whether or not that continuance is caused by volition, the state of the mind is called attention.—It is by consciousness alone that we have any knowledge of the other powers of the mind; and when directed to their operations, the appellation is peculiarly appropriate. When it is excited by sensible changes, it is usually called perception: consciousness referring to the operations of the mind, as such; perception to them as produced by external objects. (For an account of perceptions, as distinct from sensations, see SENSATION.) We are conscious of ideas and sensations; we perceive the external objects which produce impressions on the external organs. When the consciousness is suspended, as it often is, during sleep, &c. the ever active mechanism of the mental organs proceeds; in such cases, its operations sometimes excites the consciousness; otherwise we know of their existence only by their effects. On the other hand, consciousness necessarily implies sensorial changes; for to speak of the consciousness of nothing is an absurdity.

I. OF THE SENSITIVE POWER.

14. For a consideration of the leading facts respecting this faculty, we beg our readers to consult in this place the following articles in their order; *viz.* SENSATION, SIGHT, SMELL, SOUND or HEARING, TASTE, and TOUCH. In the first will be found a brief account of the physical organ of sensation and motion.

II. OF THE RETENTIVE POWER.

15. Respecting this faculty see the article RETENTION, where will also be found a few notices respecting ocular spectra.

III. OF THE ASSOCIATIVE POWER.

16. This principle, if not the sole cause of all our mental phenomena, except the original production of sensorial changes and tendencies to them, has some effect in the origin and modification of all of them. It is owing to this important principle, that sensations become the signs of thoughts and feelings, by which means man becomes a social being; that the whole mental furniture of perceptions, notions, affections, passions, sentiments, emotions, &c. is formed from the simple relicts of sensation; that man from mere sensation rises to intellect, that he becomes capable of reflection, of action. In short, whatever mental operation we attend to, except at the very earliest period of mental culture, we find association the cause of its production, or intimately concerned in it.

17. The fact of the connection which exists between many of our sensorial changes has been long known; but it has generally been referred to the memory. Mr. Locke appears to have been the first who employed the principle of association to account for aberrations of judgment and feeling, and for customary connections of ideas; but he does not seem to have been at all aware, that all our ideas, except those which are produced by mere repetitions of uncompounded sensible changes (*i. e.* ideas of sensation, or simple ideas, § 8) are in reality formed by the influence of the same principle; that all our affections, and our mental pleasures and pains, are nothing more than the relicts of sensation variously combined by association.—It seems that Mr. Gay, a clergyman in the west of England, was the first who endeavoured to show the possibility of deducing all our passions and affections from association: his observations on this subject, however, as Dr. Priestley observes, amount to little more than conjecture. These, however, led Dr. Hartley to direct his thoughts to the subject; and by an union of talents in moral science, in natural philosophy, and in a professional knowledge of the human frame, with a mind unobscured by selfish tendencies, he was enabled to bring into one extensive system the progress of the mind from its first rudiments of sensation, through the maze of complex ideas and affections, to show how man rises from sensation to intellect. "After giving the closest attention to the subject in a course of several years, it appeared to him very probable, not only that all our intellectual pleasures and pains, but that all the phenomena of memory, imagination, volition, reasoning, and every other mental affection and operation, are only different modes or cases of the association of ideas;" (more generally of sensorial changes;) "so that nothing is requisite to make any man whatever he is, but a sentient principle, with this single property, which however admits of great variety, and the influence of such circumstances as he has actually been exposed to." His great work was begun when he was about twenty-five years of age; it was published in the beginning of 1749, when he was little more than forty-three years of age. He lived nine years after, but he left it without any change; and he does not appear to have written any additional paper on the subject.—As Dr. H. expected, his work remained for a considerable time unnoticed. Tucker (A. Search) was obviously acquainted with it, and owed much to it; but he seldom speaks of Hartley except respecting his hypothesis of vibrations. Dr. Priestley had the merit of bringing Hartley's system forward to the public notice; and the celebrity which he had acquired among different classes of the philosophic world attracted the attention of thinking people to the doctrine of association. About thirty years after the publication of the original work, he published an abridgment of it; in which he left out the deductions from the principal theory respecting the rule of life, the truth of Christianity, &c. and as much as he could of the hypothesis of vibrations. Since that time the system of Hartley has been rapidly gaining ground in South Britain; and it is now, probably, pretty generally adopted by those who think closely on the subject. In North Britain, owing partly to theological and metaphysical prepossessions, still more perhaps to Dr. Priestley's rough and unjus-

tifiably severe attack upon three of the Scotch philosophers, whose mental and moral character ranked high among their countrymen, the principles of Hartley have made but little progress. The philosophical systems of Scotland have been somewhat modified by it; but those who rank the highest seem little inclined to admit it in its full extent. However, the writings of Dugald Stewart shew that he has done something towards clearing the way, and the Glasgow Professor of Moral Philosophy in his lectures does more; and there is reason to hope, that when the present generation has passed away, the true principles of mental science will gain a firm hold there as well as in South Britain. We ardently wish the extensive adoption of the Hartleyan system, because, while it satisfactorily explains the causes of our mental phenomena, it furnishes the best guide in the moral and mental culture of the mind.

18. We have already stated that the associative power has two grand modes of operation, connection and composition: it is not easy to keep them distinct; but in many cases it is practicable, and often tends to precision in our reflections and reasonings. In what we shall advance respecting the operations of this power, we shall keep this distinction somewhat in view. We shall state, first, the classes of connections which exist among our sensorial changes; and, secondly, some of the principal laws of connections: we shall then proceed to detail some of the leading facts relative to compositions, and the formation of our compound notions and feelings.—It would be most strictly philosophical to begin with compositions; because connections are formed not only among simple sensorial changes, but among those also which are compounded; in other words, not only among sensations, simple ideas, and single muscular actions, but also among those which have been blended together into complex states: and we shall sometimes have occasion, in what we state as to connections, to suppose such compositions actually formed. On the other hand, connections are much more obvious and more easily comprehended than compositions; and a statement of some facts respecting the former will lead to an easier acquaintance with the latter.

19. "That one thought is suggested to the mind by another," says the elegant and philosophic Stewart, "and that the sight of an external object often recals former occurrences and revives former feelings, are facts which are perfectly familiar, even to those who are least disposed to speculate concerning the principles of their nature. In passing along a road which we have formerly travelled in the company of a friend, the particulars of the conversation in which we were then engaged, are frequently suggested to us by the objects we meet with. In such a scene we recollect that such a particular subject was started; and in passing the different houses, and plantations, and rivers, the arguments we were discussing when we last saw them, recur spontaneously to the memory.—The connection which is formed in the mind between the words of a language and the ideas they denote; the connection which is formed between different words of a discourse which we have committed to memory; and the connection between the different notes of a piece of music in the mind of a musician, are all obvious instances of the same general law of our nature.—The influence of sensible objects in reviving former thoughts and former feelings, is more particularly remarkable. After time has in some degree reconciled us to the loss of a friend, how wonderfully are we affected the first time we enter the house where he lived. Every thing we see, the apartment where he studied, the chair upon which he sat, recal to us the happiness we enjoyed together, and we should feel it a sort of violation of that respect which we owe to his memory, to engage in any light or indifferent discourse when such objects are before us."—So again every one must have noticed the connections which exist between our thoughts or sensations and muscular actions. A performer looks at the notes of his book, and the appropriate motions of his hands and fingers follow with immediate succession. While we are writing, the thoughts we wish to communicate suggest the appropriate words, and these, with an almost instantaneous succession of motions, are written on the paper before us. We are, perhaps, more struck with this in writing short-hand than long; the characters appear as the representatives of the thoughts of our mind, almost without knowing how they are made.

20. All these facts are obviously nothing else than cases of those connections which are formed by the operation of the associative power among our sensorial changes; in other words, among our sensible, ideal, and motory changes; in other words, again, but less generally, among our sensations,

ideas, and motory changes.—We should prefer employing, in what follows, the terms sensible changes and ideal changes, rather than the terms sensations and ideas, because these imply consciousness, which we have before stated is not necessarily excited by the operations of the sensitive and associative powers: we shall, however, content ourselves with requesting the reader to bear in mind, that whatever may be said respecting connections among sensations and ideas, might be stated more generally respecting connections among sensible and ideal changes. Whatever the sensorium be, or whatever be those changes of it which excite the consciousness, it is among those changes, that is, among the sensorial changes, that connections and compositions take place.

CLASSES OF CONNECTIONS.

First: a sensation may be associated with other sensations, ideas, and motory changes.

21. A sensation, after having been associated a sufficient number of times with another sensation, will, when impressed alone, excite the simple idea (§ 8.), corresponding with that other sensation.—Thus the names, smells, tastes, &c. of external objects, suggest the idea of their visible appearance; and the sight of them suggests their names, &c. In the same manner, a word half pronounced, excites the idea of the whole word; the mention of the letters a, b, suggests the idea of c, d, &c.; the sight of part of an object suggests the idea of the whole; and the sight of one object recals the visual idea of other objects which have been uniformly or very frequently seen with it.—Innumerable other instances might be given with little trouble, but we shall mention only one other, which may assist some of our readers in accounting for certain cases of apparitions. L. was one day hastily passing by a room in which a very excellent friend had usually sat in a particular chair, and in a particular part of the room. His thoughts at the time were employed on some object which did not excite deep attention, and the sight of the chair excited in his mind a vivid visual idea of his friend as sitting in that chair. The friend had been dead some weeks, and L. involuntarily came back for another vision, but without effect.—Such visual ideas, and similar ideas derived from the other senses, particularly from the hearing, are by Dugald Stewart called conceptions; and where they are vivid and easily excited, they frequently lead those who are inattentive to their sensations to suppose that they actually saw and heard, at a particular time, what they did not then see or hear.

22. Sensations become connected with ideas, so that the repetition of the sensation will excite the connected idea.—Of this case of connections the following will serve as examples. Words associated with ideas, will readily excite them even when very complex: the words hero, philosopher, justice, benevolence, truth, and the like, whether written or pronounced, immediately call up with precision the corresponding idea. The hearing of a particular national tune, is said to overpower the Swiss soldier in a foreign land with melancholy and despair; and it is, therefore, forbidden in the armies in which they serve. The sound recals various heartfelt recollections; the idea of the peace, and the freedom of their country, of the home from which they are torn, and to which they may never return. What trains of interesting thought and feeling are usually called up in the mind by the sight of the scenes of early pleasure, where passed those years when novelty gave charms to every sensation, every employment of the faculty, when hope presented no prospects but what were decked in "fancy's fairy frost-work," and present joys precluded all regret for the past.

23. Sensations may become connected with muscular action, that is, with those sensorial changes which are followed by muscular action; so that the sensation will excite the muscular action, without the intervention of that state of mind which is called will.—A person automatically (that is without any volition), turns his head towards another who calls him by his name. When the hand of another is rapidly moved towards the eye, we shut the eye without thinking about it, or even being conscious of it. When copying from any book, if a person is very familiar with the employment, the appropriate motion of the fingers immediately follows, the impression produced by the appearance of the word. In the same manner the visible impression derived from musical notes regulate the motions of the performer. "While I am walking through that grove before my window," says Darwin, "I do not run against the trees or the branches, though my thoughts are completely engaged on some other object:" the sensible impression produced by

the objects around, excite in the sensorium the appropriate connected motory changes, and these the action of certain muscles.

Secondly, ideas may be connected with sensations, ideas, or motory motions.

24. An idea associated a sufficient number of times with a sensation, will excite the simple idea belonging to that sensation.—Thus the ideas, whether simple or complex, which have been sufficiently associated with names, excite the ideas of their respective names. Hence it is that we find ourselves continually thinking in words; that is, the trains of ideas which pass in our minds, are accompanied with their corresponding expressions, when those expressions are familiar to us: and it may be remarked that the habit of thinking in words is one which contributes greatly to accuracy and facility of thought, and therefore one which the young reasoner will do well to cultivate.—Those who are habituated to reasoning, find their trains of reasoning so generally clothed in words, and words so necessary to their intellectual operations, that the words are what they most attend to, and some have even gone so far as to suppose that general reasoning is concerned merely about words and not about ideas. They seem to lie under a similar error with those who imagine that the visible appearance of objects is all we attend to when we speak of magnitude, shape, &c.; whereas the fact is, that the visible appearance is nothing more than a symbol which serves to introduce the connected complex idea into the mind and to keep its parts connected: and this then is the grand end of words in general reasoning.—We are conscious while we are thinking, of employing the relicts of audible sensations; we seem to have faint sensations of sounds passing in the sensorium; but it appears probable that those who have long lost the use of their hearing, and have generally employed sight as the inlet of knowledge, have a train of visual, instead of audible conceptions. All, however, which we particularly wish to have noticed here is that these things afford instances of the connections of ideas with sensations, so that the idea introduces the simple idea belonging to that sensation.

25. Next, an idea associated with an idea, (whether notion or feeling) will excite that idea. Thus the idea of benevolence will excite that of merit; of courage, that of honour; of great talents, that of respect; of cruelty, that of horror; of meanness that of contempt.

26. Again, an idea associated with a motory change, will excite that motory change, (and its consequent muscular action).—Thus, the desire to perform a particular action will produce the corresponding voluntary motion of the limbs; joy produces a pleasing cast of countenance; fear excites trembling; and horror distortion. In the same manner when we are employed in committing our thoughts to writing, the idea of the words which we intend to commit to paper, if the character be not peculiar, or novel, will immediately suggest and be followed by the appropriate motion of the fingers, and this without the intervention of volition, sometimes without even the consciousness of the motory changes, or of the muscular actions produced by them. So also in speaking, unless some difficult pronunciation occur, the muscular actions requisite for the formation of the sounds follow immediately the conception of the words, without the intervention of the will.

Thirdly, motory changes, (and their correspondent muscular actions), may be connected with sensations, ideas, and other motory changes, (and their correspondent muscular actions).

27. Muscular actions may be associated with sensations; that is, when muscular actions have been sufficiently long associated with sensations, the repetition of the muscular action alone will excite the simple idea belonging to that sensation. Thus the action of dancing will bring to mind the conception of the music with which it has been often accompanied. Again children often accustom themselves to particular motions of the limbs, while committing to memory, or while repeating what they have learnt; and those muscular actions in many instances become necessary to their correct, and ready recollection, and even to their recollection at all. Addison, says Miss Edgeworth, represents with much humour the case of a poor man, who had the habit of twirling a bit of thread round his finger; the thread was accidentally broken, and the orator stood mute.

28. So again muscular actions may be associated with ideas; that is, when muscular actions have been sufficiently long associated with ideas, those muscular actions will excite those ideas: thus dancing will introduce cheerfulness into the mind. So particular muscular actions have, from habitual connection, a tendency to excite certain trains of thought or states of mind:

those who have been accustomed to one posture while studying, find it difficult to study so well in any other posture; and persons who, while engaged in deep meditation, have been accustomed to any little motions of body, find the continuance of those motions requisite for the continuance of their abstraction of mind. It is upon the same principle that certain postures of body have a tendency to produce those feelings which all should have when addressing the Supreme Being.—The cases, however, in which muscular action introduces ideas either simple or compound, are much less numerous than those in which sensations and ideas introduce muscular actions. In fact it is not the usual order of association; and besides, it is sometimes very difficult to say what effect is produced by the muscular action itself, and what by the sensations which generally accompany muscular action. In the next case the point is clearer.

29. Muscular actions become connected with other muscular actions (that is, the motory changes which produce the one with those which produce the other), so that the former may introduce the latter without the intervention of the will.—If different muscular actions are produced together, they are called synchronous; if one immediately follows the other they are called successive, and the association is in like manner termed synchronous or successive.—The motions of the hands when a person is playing upon the piano-forte, the motions of the hands and feet in weaving and in spinning, and various other muscular actions which will readily suggest themselves to the reader, may be stated as instances of synchronous associations of muscular actions. The motions of the organs of speech in reading or speaking, of the feet in walking, and of the fingers in writing or speaking, are instances of successive associations of muscular actions.

30. These nine cases of the association of sensorial changes are comprehended by Hartley in the following general theorem: "If any sensation, A, idea, B, or muscular motion, C, be associated for a sufficient number of times with another sensation, D, idea, E, or muscular action, F, it will at last excite, *d*, the simple idea belonging to the sensation, D, the very idea, E, or the very muscular action, F."—The sensation itself cannot of course be re-excited, because that depends upon the presence of the object of the sense; but sometimes, as in an instance stated in § 21, the simple idea belonging to a sensation is so vivid, that it equals, if not surpasses the original sensation; and it should be observed that the sensorial change corresponding to the sensation, is the same in kind as that corresponding to the simple idea left by that sensation; that is, any sensible change and its simple ideal change are the same in kind, differing only in vividness, and sometimes equal in that respect.—It may also be well to observe here, that when Hartley and his disciples speak of muscular actions clinging together, they obviously mean that the motory changes of the sensorium become connected together, and not as some seem to have supposed, and indeed as, their words imply, that the motions of muscles are connected without any intervention of the mind (taking the term in the popular sense). It is true they suppose that volition has nothing to do in the association when complete, though originally perhaps concerned in the formation of the association; and also that it may go on without even exciting the consciousness; but we know of none who suppose that the mental organs (the mind in the popular sense) are less concerned in the connections among muscular actions, than in those among sensations and ideas. All the sensorial changes may and do become connected together, and the one may produce the other, and so on, without the consciousness being excited; but no external impression, which does not act by stimulating or impelling the moving muscle, can produce muscular action without the action of the mental organs; and, in like manner, no muscular action can produce another muscular action (except what may be termed mere physical motion, such as might be produced by any foreign body mechanically acting upon the muscular system), without the action of the mental organs. The whole of the connection is mental, and we think that if this idea be kept in view, and employed in the explanation of the Hartleyan phraseology respecting connections among muscular actions, that it will remove some of the difficulties which are felt respecting this part of the Hartleyan system, and show that the objections which have been urged against it arose from an incomplete idea of that system.

LAWS OF CONNECTIONS.

We now proceed to our second object (§ 18.), *viz.* to point out and illustrate some of the leading laws of that class of associa-

tions which we term connections; premising that many of the observations which follow are, as the reader will readily perceive, equally applicable to that class which we term compositions.—These laws regard, 1. The strength of connections; 2. The disunion of connections; 3. The formation of connections by means of intermediate links (which we may call the law of transference); and 4. Habitual biases to particular kinds of connections.

1. *The Strength of Connections.*

31. The strength and durability of connections depend partly upon the degree of attention with which the connected sensorial changes have been attended, and partly upon the frequency with which they have recurred in connection; less generally, partly upon the vividness of the connected ideas; and partly upon the frequency with which the connected ideas, or muscular actions, have recurred in connection.—We may adduce, as an illustration of the former cause of strength and durability, that circumstances of a light and trivial nature, which have occurred while our minds were occupied with subjects of a strongly pleasing nature, form no connection with the concurring train of ideas, even if the attention were drawn off by them. For instance, suppose we were attending to an interesting discourse, if our attention were for a moment called off by the coughing of a person near us, the train of thought suggested by the sermon would form no connexion with the cause of the interruption, and it would pass in the mind without the idea of the interruption being introduced. But suppose a poor man to have fallen down in a fit of apoplexy, the circumstance would strongly interest our sympathy and excite our attention; many feelings would be brought into active exercise; and the ideas which were at that time in the view of the mind, would probably ever after present with them those of the scene which so strongly affected us.—Hence the importance that those who have the care of education, should seize the happy moments when circumstances have peculiarly interested the mind, to connect with them those related maxims of prudence, benevolence, and piety, which so introduced may have a lasting effect in regulating the disposition; but which, brought in a form less interesting, will have no permanent bond of union, and will soon be obliterated.—Hence, too, the importance of instilling into the mind those principles which are designed to have a constant operation in the thoughts, and feelings, and actions, of life, in such a form that they shall become connected with those thoughts and feelings which have already a firm hold in the mind, and thus be brought into view and excited into action much more frequently and uniformly.—The effect of frequent recurrence in producing strength and durability of association, may be best explained by the associations which take place between words and their corresponding ideas. These connections are not in general attended with any particular cause of association, except frequency of recurrence, and therefore they are the most unexceptionable instances. Now, other things being equal, we find that those words which are most frequently called up in the mind in connection with the ideas to which they belong, have a closer connection with those ideas; that is, the idea suggests the word, and the word suggests the idea, with greater certainty, and the association is more permanent. The following remarks of Dr. Percival will illustrate this general principle. "Slight paralytic affections of the organs of speech," says the Doctor, "sometimes occur without any corresponding disorder of the other parts of the body. Hence the effort to speak succeeds the volition of the mind slowly and imperfectly, and words are uttered with faltering and hesitation. These are facts of common notoriety: but I have never seen it remarked that in these local palsies the pronunciation of proper names is attended with peculiar difficulty; and that the recollection of them becomes very obscure, or is entirely obliterated, while the recollection of persons, places, and things, remains unchanged. This confirms the theory of associations, and at the same time admits of an easy solution by it. For as words are arbitrary marks, and owe their connection with what they impart to established usage, the strength of this connection will be exactly proportioned to the frequency of their recurrence, and this recurrence must be more frequent with specific terms."

33. Besides these two universally operating causes of the strength and durability of association, it is proper to observe that they depend also upon the predisposition of the mind, the habitual bias of thought and feeling, and the prevailing cast of the associations already formed. This may in

part be resolved into the first cause, the degree of vividness of the connected ideas; but in part it must be considered as separate. Where there are associations of a contrary tendency, the production of the new association implies the destruction of the old one; and hence it is that persons who have passed the prime of life feel it so exceedingly difficult to acquire new associations which are in opposition to those long formed. Hence it is that all those improper biases of thought and feeling which oppose the best regulation of thought and feeling, should be carefully shunned; all those associations carefully prevented which lead the mind away from God and duty, or which simply check the reception of those which accord with the dictates of religion. They do more than directly injure by their own existence; they injure also, and this in no small degree, by preventing the formation of those associations which directly prompt to the course which duty points out.

34. An acquaintance with these principles leads us to the direct method of confirming associations which are essential to our well-being; suppose, for instance, the connection of a regard to the will of God, with our conduct, we should endeavour to connect as much as possible those pleasurable feelings which have a tendency to strengthen the links of union, we should cultivate the connection by frequently and continually bringing it into action, and we should carefully cultivate those related states of mind which have a tendency to foster and strengthen the connection. To avoid weakening it we should be careful not to associate any contrary trains of ideas (for instance, we should never attach feelings of ridicule with any thing connected with religion), and should carefully avoid those breaks in the association which will follow neglect in its cultivation. And it is a most satisfactory idea that if vicious associations may be formed so strongly as to lie beyond the power of the individual to annihilate them; virtuous associations may also be formed so strong and permanent as to bid defiance to time and to temptation. These shall survive the wreck of nature, and shall adorn the mental fabric when this world, and all its sorrows and enjoyments, shall be no more.

2. Disunion of Connections.

35. As connections are necessarily formed, and frequently without any volition on the part of the individual, by the before mentioned circumstances, it is another very important law of the associative power that these connections are not indestructible.—We observe then that an association may be destroyed either by the formation of other contrary associations, or by the repetition of it being in some way or other prevented. Thus, for instance, if we wish to destroy the association by which we have attached ideas of merit to those spurious ideas of courage which lead a man to sacrifice the life of a fellow man, and perhaps the happiness of several, to the dictates of offended honour, our aim must be to associate all the dreadful consequences of his conduct with the conduct itself; to call to mind the injury to society resulting from the violation of its laws and the deprivation of an useful member; the injury resulting to the connections of the individual from the cruel breach made in their peace and among their means of happiness; the injury to the individual himself by hastening him unprepared into the presence of his Maker, with this additional act to answer for: even the injury to the avenger, by cultivating the feelings of resentment, by loosening the restraints of passion, may be added to the already numerous evils resulting from this exercise of private revengé. These frequently brought into view would destroy the incorrect association which we had formed; would associate demerit instead of merit with the conduct of the duellist; and attach the idea of merit strongly to him who nobly resisted the opinion of the world of honour, and declined obedience to the laws which it imposes, where those laws were in contradiction to the laws of his conscience and of his God.—So, in numerous other instances, where an association unfortunately exists in the mind unfavourable to the formation or exercise of good dispositions, it may be weakened gradually indeed, but certainly weakened, and at last destroyed by the steady culture of opposite associations. That conduct to which pious benevolence prompts, may acquire so attractive an appearance, that ideas of difficulty, of pain, of ridicule, which may have been attached to it, and which may have impeded its exercise, will gradually give way to those which the divine approbation affords, of present peace and future happiness.—But there is not always time for this slow procedure. It may be necessary for individual happiness, that the baneful association should be destroyed without one repetition of it to confirm its power. To the general culture of opposite associations must then be added a steady careful pre-

vention of the introduction of the connected ideas. Situations must be avoided, words disused, company shunned, which have a known tendency to introduce a train of thought leading to the first link of the chain which we wish for ever separated.

36. When we hold it out as a grand law of association, that connections may be disunited by forming opposing associations, and by preventing their repetition, we would by no means represent it as in general an easy, or as in all cases a practicable task.—When associations have been long formed, and often repeated, particularly where they accord with the general bias of the mind, they often bid defiance to the most strenuous exertions of the individual. If he could for a long time prevent their repetition, and successfully cultivate opposing associations, the most inveterate associations would by degrees loosen their power; but when associations have been strengthened for a long period of time, by being frequently brought into play, and connected with other active associations, and at the same time accord with the prevailing disposition of the mind, the prevention of their repetition, and the culture of opposing associations, is scarcely practicable.—These things may be viewed in various lights, some gratifying to the mind, some which must urge every thoughtful person to shun the formation and culture of those associations which he must some time or other wish to break. While they teach us to be assiduously careful to prevent all such, they also shew us that those which we must wish to cherish may as well as others of a contrary character, become invincible; and while they direct those who have the care of the young, carefully to cultivate those tendencies to feeling and action, that is, those associations which may serve as a check upon improper associations, while they direct them carefully to prevent those which may acquire a despotic rule in the mind to the destruction of peace and virtue, they also diminish the anxiety which we are sometimes prone to feel when we find ourselves unable to mould them exactly to that standard of thought and feeling which we wish.

37. It may be well to enlarge a little here. Numerous are the associations, particularly of a speculative nature, which yield to the influence of time and change of circumstances. In many instances the destruction of the association depends upon the efforts of the individual; but in the greater number it is occasioned without his direct efforts, by the increase of his knowledge, by circumstances preventing the recurrence of the association, or by the formation of contrary associations upon more solid grounds. But that they may be broken should never be allowed as a reason for the formation of improper associations; for the difficulty is frequently great, in many instances insuperable, except by such discipline, such peculiar concurrences of circumstances as fall not to the lot of every individual. The association between certain motives and that state of mind which we call volition, formed in early life, and strengthened by frequent repetition, is frequently found so indissoluble, that it leads the unhappy individual to act against his better judgment, and the destruction of his corporeal, and even of his mental energies, produced by his conduct, prevents those exertions for his release which he wishes to make, but has not the power to attempt.—In every mind, more or less, circumstances generate desires and passions, these generate volition, and volition produces action. How few are there who have attained the power of voluntarily separating passion or volition, or rendering them less connected; or of repressing those passions which were previously invariably connected with the circumstances which gave them origin. In all men the train of thought is partly involuntary: how few are there who are capable of directing their associations into one channel by the exertion of volition, and employing them in one definite way; of destroying improper associations, and of forming new ones, actuated by a view to the claims of duty, and to their improvement in wisdom and virtue. How frequently do we see others (and self-knowledge will shew us repeated instances which come home to our own bosoms) in situations where they act against their better judgment, a situation which is so forcibly described by the apostle, "for that which I do, I allow not; for what I would, that I do not; but what I hate, that I do." This we can easily account for upon the principles of association. He who is in such a situation, may be convinced that certain actions are wrong, that they will infallibly injure his future happiness, that they must imbitter his present enjoyment: but his conviction comes too late. The object which promises the gratification of some or other of his powerful principles of action, presents itself to his mind; it strongly prompts his desires or his passions; the association between these

and volition, is perhaps of very long standing, confirmed by repeated exercise, not counteracted, or but weakly, by any contrary associations, or by any exertion of the individual; it is impossible to overcome it, or at least, it can be overcome with extreme difficulty; the mind sinks under the trial, and the commission of the action tends to strengthen the association, to render the mind still more the slave of vice and misery.—The picture unhappily is not too highly drawn; and though the habit may not be so deeply fraught with unhappiness, few are those who can say that they have not one confirmed habit which they would wish to change, or at least to weaken. If these have made the attempt to destroy the connection between desire and volition; the difficulties cannot have appeared trifling.

3. *Law of Transference.*

38. We now proceed to state and to explain that important law of association, agreeably to which associations are formed by means of intermediate links. We must here request our readers to bear in mind, that we use the word idea in the wide sense in which it is employed by Hartley, to denote every internal feeling except sensation, whether simple or compound, whether or not accompanied with pleasure or pain.—The law to which we have referred may be thus stated. One idea may become connected with a second, by means of their mutual connection with a third; and where it is not necessary to attend to this third or intermediate idea, the more the connection between the first and second is confirmed, the less will the third be perceptible; so that when the association becomes completely fixed, the intermediate idea is often lost entirely from the view of the mind. The absence of the intermediate idea is often so complete, that its ever having been present can only be discovered by tracing the progress of the connection between the extremes; and in certain cases where the association has been long in a perfect state, the difficulty may become so great, that we are inclined to admit an intermediate idea, only because we feel it in other similar cases, and perhaps in the very same connections in other individuals whose habits are less fixed.—This law, or mode of operation, of the principle which we call association, meets us at almost every step of our reflection on what passes within us. It may be termed the law of transference, and we shall state it again in another form. Let A, B, and C, represent three ideas, simple or compound, pleasurable, painful or indifferent. If A is connected with B, and B with C, A may be transferred to C, and be recalled by it, without B being present in the mind.

39. This is an exceedingly important and constantly operating law of association: it is thus that numerous, almost innumerable phenomena are produced, which at first sight appear inexplicable upon any known principles, and which therefore are referred to instinct; that is, they are supposed to result necessarily from the conformation of the mind, without the operation of any acknowledged faculty of the mind. Such are the belief in what is called self-evident truths; the pleasures derived from objects which do not affect the mind by direct sensations, disinterested affections, &c.—Whenever we meet with the word instinct applied to the human mind, we are to consider it simply as an appeal to ignorance; and though it seems often to be held out as the solution of a difficulty, it is, in fact, nothing more than saying, the feeling, or whatever else it be, springs up we know not how; we know nothing of its origin, progress, or exercise. The term instinct explains nothing, and though it is conveniently used with respect to the minds of brutes, of which we can learn nothing with certainty; yet when applied to the human mind respecting whose operations we may often gain correct ideas, it is worse than saying nothing, for it stops investigation by a pretence of knowledge. It is true, we cannot trace many links in the chain of cause and effect; but as far as the great Creator has furnished us with powers, we need not be afraid to employ them, while their employment is conducted with judgment and caution.—We do not say that all those feelings which we are too apt to call instinctive, can in the present state of our knowledge be completely analyzed, and traced to their origin; but while so many can, so many too which in no respect differ from those which we cannot account for, except in the opportunity which we have of accounting for them, we have a full and fair right to say, that as attention to mental science increases, these difficulties will diminish, and that by degrees the whole of our mental furniture will be traced, as we can trace a great part of it, to sensations, retained by the retentive power, and com-

bined and variously modified by the associative power.—We have no objection to the term natural feelings, &c. rightly explained; the word is abused, and often means the same as instinctive. We understand by the term those feelings, &c. which in all cases, where there is not something peculiar in the individual, will spring up in the mind, in consequence of the influence of generally occurring circumstances upon the powers with which the great Former of the mind hath endowed it. For instance, the parental, the filial feelings, &c. are natural feelings: in all cases where there is not something wrong in the individual, these feelings will spring up in his mind in consequence of the influence of generally occurring circumstances upon the powers with which the mind is endued. So also a great variety of other feelings, which, with the strictest propriety, may in this sense be termed natural.—Some objection, however, lies against another word often used in a similar way. Such feelings are said to be *implanted*. If the word be understood to mean nothing more than what some do mean when they use it, that the feelings, &c. spring up in the mind with the same certainty as though they had made a part of the original structure of the mind, all is well. But if it be understood to mean that these feelings do form a part of the original structure, then it implies the same cutting of the Gordian knot, the same appeal to ignorance, which is implied in the use of the word instinctive. If, however, we can restrict its signification in our minds we shall do well. Let it mean no more than that the feelings, &c. to which it is applied, are the necessary results from those powers which the Supreme Being has implanted in us; in fact, let it have the same general meaning as natural, with rather more force, denoting the necessity of their arising from the powers which are given us, and we shall not be giving way to those erroneous views which we must unlearn before we can acquire truth.

40. We need not go far for instances which will explain the law of transference. Suppose a person acquiring another language, the French, for instance; he learns the meaning of a French word by means of the corresponding English word; by degrees as the French word becomes familiar to him it is understood without the English word being thought of. Here the signification, that is, the idea connected with the word, may be called A, the English word B, and the French word C; by frequent connection between A and C, by means of B, A is transferred to C, the signification is transferred to the French word, so that B the English word is no longer wanting to form the link of union.—When a young person has acquired some facility in construing French, he generally reads his French work in English; but when he has acquired a pretty complete knowledge of the language, he reads it in French, that is, he understands it without the intervention of the corresponding English words.—Those who are conversant with short-hand, can read it without thinking of the long-hand; yet they learnt this through the medium of the long-hand words.—Those who have long learnt to read, and who have read much to themselves, seldom think of the sound of the words when they are reading to themselves. When we are pretty familiar with a subject, a single glance of the eye over a page of a clear printed book, will convey to us the idea of its contents, when perhaps not a single word has particularly attracted our attention, when certainly there has not been time for the mind to think of the sound of the words. We do not recommend this habit of reading to young persons; but simply state a fact which is very convenient and useful to the mind, which has gone through sufficient discipline of accuracy, &c. Now it is obvious that in almost all cases, persons learn to understand written words through the medium of spoken words.—One more instance and we have done with mere illustration. Those who are familar with writing never think of the printed word unless any particular circumstance call it to the mind. Yet there are very few instances in which the written word is not connected with the spoken word by means of the before learnt printed word.

41. I now proceed to show the application of this law, in explaining certain phenomena of belief, and the origin of disinterested affections. I am not now to attempt the explanation of the formation of the complex feeling which we call belief, nor of those complex states of mind which we call affections; but supposing them formed, to explain some facts respecting them, that is, to shew how these facts accord with the general law of association which I have been stating.—Belief is transferrable from the reasoning to the result of that reasoning. Suppose a proposition depends for its truth upon a great number of other propo-

sitions, if, as we go along, every step is believed to be true, and every connection of one step with another appears to be a just one, the feeling of belief is successively transferred from one step to another, till at last we come to the result, the proposition which we wish to prove, and the feeling will be connected with this, and will remain with it, when all the steps by which its truth was shewn, are entirely lost from the view of the mind. Every one admits this; and every one who has gone through the process knows it to be so.—There are almost innumerable instances in which we find the feeling of belief connected with ideas, without our being able at once to say, or even to say at all, how we acquired the connection. In this instance some philosophers refer to certain instinctive principles, by which we are necessarily led to believe, without any further reason than that our mental constitution compels it. But we need not resort to such hypotheses; they do great injury, by checking the researches of the intellect, and in some cases, by leading people to suppose opinions well founded, which have no further ground than an almost accidental, or, at at any rate, unjust transfer of belief, by means of what was itself, perhaps, intitled to no belief.—There are certain results of reflection and observation, which we call experience; and it is generally wise to trust to them. But before a man yields to his experience, in opposition to the clear evidence of others, or to well-founded and well-connected reasonings, he should consider what experience is, and on what ground he has connected belief with it. He will find that belief is not a necessary attendant upon his experience, but that it has been connected with it by means of intermediate links, which might themselves have no satisfactory claim to belief. For instance, if a man has not observed accurately, or has not a correct judgment, his experience may not be worth any thing, nor intitled to any belief. Now, in many cases, it is almost impossible to recall the intermediate links, in order to prove to ourselves the correctness of our experience, and yet we must act upon it; this shews the importance of cultivating in early life those habits of cool judgment and accurate observation, which shall give us a full right to believe, and to act upon our belief, in the results of reflection and observation; but some truths, it may be thought, have a necessary connection with belief. We admit that there are truths which are so accordant with all the grounds of belief, that they instantaneously excite the belief of those who have had the opportunity of knowing those grounds, but no further. You immediately believe, that $2 \times 2 = 4$; and you would think that man destitute of common sense who denied it, or who did not immediately admit it. Yet we are well convinced, that the belief is formed in consequence of a number of external impressions; or, to state it more familiarly, by frequently counting, in the early part of childhood. We perhaps have not the power of discovering the exact steps by which we have ourselves proceeded to the belief of this truth; but we can observe them in some good measure in others, and we can trace them in ourselves, in similar circumstances. Often belief in such truths is formed through the medium of parental authority, or that of instructors, and it is probable, that in many instances children know no more why $12 \times 12 = 144$, than that they find it so in their multiplication tables; but where it has been formed by trials of the truth, those trials are forgotten, and the truth alone is remembered.—We should gladly enlarge more on these points, but what has been already said will probably answer the two purposes which we have in view, to show the operation of association in transferring belief; and in leading to the inference, that belief ought not to be regarded as a proof of truth; and yet, that the being unable to point out all the grounds of belief, is not any reason why that belief should be given up.

42. Two opposite opinions have long been entertained, and are still often advanced, respecting the disinterestedness of the human mind; some have maintained, that the mind, in all its feelings and promptings to actions, is actuated by selfish motives; that, in fact, there is no action or feeling which can be called disinterested. Others have with more success maintained, that the mind can be, and often is, disinterested; that a person frequently performs an action tending to the good of others, in a greater or less degree, without the remotest reference to himself, with no other motive than a desire to do the good which is the effect of the action. The degrading system of the former is seldom adopted, but by speculative men, who have been led by circumstances, happily not universal, to see merely the dark side of human nature, and to form a more gloomy picture of its selfishness than truth would allow; or by

others who have expected too much from the beautiful speculations of theory, and having been disappointed by comparing them with their own feelings in many instances, or with the general conduct of men, have thence gone to the unfounded opinion, that all the actions of all men are selfish. If the opinion of those who maintain the disinterestedness of the human mind, had not been carried to an extreme, it would have been attended with but little inconvenience; but unhappily its virtuous advocates have thought disinterestedness an innate principle of the mind, and have considered it as the first step towards true worth of character, whereas it is in reality the last; and have therefore decked the commencement of virtue in colours which belong only to its completion: and hence two practical ill consequences have followed; some persons have neglected the culture of disinterestedness, both in their own minds and in those of others, from supposing it to be a necessary quality of the mind: and others have been driven to despair, on comparing the representations of theory with the faulty state of their own minds; supposing that they could never attain to what is considered as alone intitled to the appellation of virtue.—The more correct views, surely, are, that disinterestedness is the last stage of an affection; that it may be hastened or retarded, by attention, or neglect of the culture of that affection; and that disinterestedness, as the general character of the mind, is the highest point of excellence, and what should be our object, but can only be acquired by a long course of religious culture.—When an affection has arrived at its most complete state, in which it has no further end than its own immediate object, (that is, when the object is desired for its own sake), the affection may be called disinterested; but as this term would thus be applied, not only to the worthy, but the baneful affections, we should be compelled to speak of disinterested cruelty, disinterested avarice, &c. we shall therefore call those affections which are in their ultimate state, ultimate affections.—Premising this, we shall adduce some instances which will explain the progress of an affection, from the state in which the object of it is a mean, to that in which the object of it becomes the sole end; that is, in which it is an ultimate affection.

43. The most simple instance, and what is frequently adduced for this purpose, is the love of money. Money is first an object of pleasurable feeling, merely as a means of procuring other things which are regarded as objects of desire. For a moment we may sometimes think of it, as having some intrinsic value independently of its utility as a means; but we may satisfy ourselves that this is not the case, by observing how little it is an object of interest to children who have not heard much about it, or seen it employed, or employed it themselves. A child is perhaps pleased with a piece of money as a plaything, but nothing further, and children sometimes advance considerably far in life before they feel its value. E. (a boy of seven years old) was presented by his father with half a crown, as a reward for a very successful and persevering effort; he was delighted with the approbation which was shewn him, and as far as the money was a mark of that approbation it pleased him; but obviously nothing further. In small families children generally learn the value of money early, and we therefore mention the circumstance as an illustration of what we have just said, that originally it is merely desired as a mean. As persons advance in life, money is continually found to be the mean of a great number and variety of the sources of present enjoyment; hence pleasurable feelings are continually connected with it, and it becomes more and more an object of desire. In this stage of the progress of the love of money, it is desired as the means of procuring certain pleasurable feelings, without reference to the objects by which those pleasurable feelings are directly produced. And even in this state of it we find an instance of the law of transference. The pleasurable feelings resulting from the objects procured, or to be procured, by money, are associated with the money itself, without reference to those objects. To revert to one of the modes in which the law was proposed, here the pleasurable feelings which purchasable objects produce; the idea of those objects; and the idea of money, are the three sets of ideas. Money procures the object, the pleasurable feeling; hence the pleasurable feeling becomes connected by means of the intermediate links with money; and hence money becomes an object of desire, without any reference to the means of gratification which it procures. — Here, to use the other statement, the pleasurable feelings may be termed A, the object which produces them B, and money which produces those objects C; and by frequent connection between A and C by

means of B, A is transferred to C, the pleasurable feelings are transferred to the idea of money (and consequently to money itself) and are called up by it without any reference to B, the objects by which those pleasurable feelings were excited.—The law of transference may, in this instance, and many others, be carried one step further. In this state money is desired, on account of the pleasurable feelings with which it is connected; but by degrees the desire is transferred from the pleasurable feelings with which it is connected to money itself, and money is loved for itself, without any reference to those pleasurable feelings. This is so important a fact in our mental constitution, and what can be explained only by association, that we deem no apology necessary for endeavouring so much at length to point out its application. Here A is the desire which is excited by B, the pleasurable feeling connected with C, the idea of money: by means of B, A, the desire, is transferred to C, the idea of the money; and thus money comes to be desired for itself, without any reference to the pleasurable feelings which it is the means of procuring. In this state the desire of money is become an ultimate affection; it is no longer desired as a means, but as an end; it is desired on its own account.

44. Illustrations of a similar kind might be offered with respect to the filial, fraternal, and even the parental affections; and it might be shewn that they are only gradually disinterested; but at the same time the natural tendency is to disinterestedness: and that it is only where disinterestedness is opposed by the culture of wrong affections, (affections which, when become ultimate, are ever selfish), and by neglect of those which are in all their stages worthy and which hasten the progress almost indefinitely, that the mind stops at partial disinterestedness or sinks into confirmed selfishness.—In opposition to these views, however, it may be advanced by some that children are usually more disinterested than persons who have had experience in life. We shall make some observations on this point, which will at the same time throw some light on the progress of the filial affections. Children often appear disinterested where they are not really so, because we do not take into account the quick changes of their feelings; sometimes setting a light value upon what a few hours, or even minutes, before they were delighted with, and at other times the reverse. Hence they are readily induced to give away what they have before been delighted with, and to make what we erroneously think sacrifices without an effort.—But again, we are apt to think them disinterested when they give up what they really like, only, or principally, because they thus have a greater share of the pleasures resulting from their obedience to their friends' praise, or other rewards. Now the approbation of their friends is to children a thing of such value, that praise affords them some of their greatest pleasures. And therefore when for the sake of that approbation, they give up play-things or niceties, or any other objects of pleasure, so far from being disinterested, they are eminently self-interested; but their self-interestedness is of a better kind, one which with due care will prove a most powerful engine in the moral and religious culture of the mind, by increasing the influence of the parent and instructor.—Again, children are in general influenced more by present objects than by future objects, however far superior in their value and durability. Few children early attain such command over themselves as voluntarily to give up a present source of pleasure for a future one; and where it is done, it is rather in compliance with the wishes and injunctions of their friends, than from any comprehensive conception of the future good. It is an excellent thing to obtain the sacrifice by means of any worthy feeling; all we wish to observe is, that children do not feel the value of future pleasures, and therefore easily yield to that which is most powerful at the time. Hence therefore they appear disinterested because they cannot calculate the value of the good which they relinquish; and do in reality prefer the greatest present pleasure, or rather they are in reality actuated by the greatest present pleasure.—We do however cheerfully admit that children very often are disinterested; for instance, will obey their parents, will tell the truth, will endeavour to increase the comforts of others, without any reference direct or indirect to any personal gratification; and we admit too that these same children too frequently as they grow up become more selfish, and sometimes the constitutional readiness with which they have in some instances become disinterested, will be the cause of their becoming selfish, and that to a degree which those of less promise never experience. All this may be easily explained, but we must confine ourselves to the fact, that

children in a very early period shew great marks of disinterestedness. Now this may easily occur, especially where there has been proper culture on the part of the parent. Where the approbation of the parent has been made the greatest good, by being uniformly given to that which will promote the real happiness of the child; and where, consequently, prompt and cheerful obedience has been early and steadily cultivated, a tendency to obedience will soon become so habitual as to leave scarcely a wish to deviate even in cases where obedience requires real sacrifices, and in general to prompt to propriety of conduct, without any reference even to the increase of parental affection, or to the occurring of parental approbation. Obedience is then disinterested: and the affection on which it is founded—the desire of doing whatever a parent directs, is become ultimate. Where this is confirmed by other worthy feelings, the highest effects may be reasonably expected in the moral character; and the foundation will have been laid for that regard to the will of God which is the beginning and the end of wisdom.—But we need not for this resort to any opinion of innate disinterestedness. Let us observe how it arose from firm but temperate decision on the part of the parents, from an enlightened wish on their part to promote the happiness of their child, by making its present pleasure subordinate to its happiness on the whole, from checking their own irregularities of disposition, so as to raise no suspicion in its mind that their own pleasure was their object, and by aiming to connect, by all the rational means in their power, pleasurable feelings with obedience, painful feelings with disobedience. We suppose there never was yet an instance, where all this was done, and done sufficiently early, where the effect did not follow. And the habit of disinterested obedience may be formed much easier in the earliest period of life than in those further advanced. There are then no opposing habits which must be checked before obedience can be secured: little pains are quickly forgotten though their effects remain; future pleasures are thought of but little, and the value of their sacrifice not falsely estimated; above all, the constant connection is formed between good and obedience, by various methods of obedience, and between unpleasant feeling and disobedience.—The desire of obeying parental directions is the feeling which we have been considering; but precisely the same observations may be made with respect to the wish to increase parental happiness, and remove parental pains: and where parental influence has acquired such power, we need not go a step further to ascertain the cause of a disinterested love of truth and other virtues.—We do not think that a child who has been thoroughly disciplined, so as to have formed the confirmed habit of prompt affectionate obedience, and who has had this feeling transferred to his heavenly parent, by the wise instructions of his earthly parents, will ever wander far and long from the road of duty; but in other cases, where the habit is less confirmed, or not rightly directed, it often falls before the influence of erroneous views as to the efficacy of the means of private happiness, before the constant influence of example, before the influence of disappointment, &c.: but these effects our limits will not allow us to explain; we merely wished to show how disinterestedness might spring up very early in the mind.—These things, so far from giving any countenance to the theory that the human mind is originally disinterested, confirms the theory that disinterestedness is the growth of custom; and point to various important practical conclusions, which parents will do well to lay to heart, to make the regulating principles of their conduct.

45. We will now proceed to the two last objects which we had in contemplation, the formation of disinterested benevolence, and a disinterested love of duty.—Every human being receives his first pleasurable impressions in society. His appetites are gratified by the assistance of his kind; and probably there is no agreeable feeling which is not in some way or other associated with those who attend him in the period of infancy and childhood. Hence arises sociality, or the pleasure derived from the mere company of others: and, as the child increases in years, the associated pleasure increases almost continually. In the innocent and generally happy period of childhood, he receives all his enjoyments in the company of others; most of his sports and amusements require a playfellow; and if by any untoward circumstances he is prevented from joining his companions, he feels an uneasiness which it is scarcely in his own power to remove, but which vanishes as soon as he can rejoin them.—But his happiness derived from others, depends greatly upon the happiness of others. He is happiest when those around him are happy; partly

from the contagion of feeling, and partly because his means of happiness considerably depend upon the convenience of others. If his companions are ill, his sources of pleasure are diminished; if his parents are unable to take their customary care of him, he misses it in various ways, he loses the caress of affection, or the little kindnesses of parental tenderness. Hence the comfort and happiness of others necessarily becomes the object of desire; and even in children, it not unfrequently happens, that this desire becomes sufficiently disinterested to forego small pleasures, or endure small pains, in order to increase the comfort of their parents, or to prevent what would diminish it.—Benevolence is that affection which leads us to promote the welfare of others to the best of our power; and general benevolence is founded upon particular benevolence; for instance, upon affection to parents. We have seen the rudiments of it spring up; and that in some instances, even in children, it becomes disinterested: but it has been in only one branch, and it will be well to pursue it further.—The endeavour to promote the comfort or welfare of others, is almost invariably followed in the early part of life with an increase of pleasurable feelings. Parents approve, and tell children that God approves, of those who do good to others. Children and young people are continually feeling and observing the good effects of benevolence, as manifested in their own conduct, or in that of others; and hence, in well-disposed children, the pleasurable feelings connected with benevolent actions are very strong; they are very glad to see others made happy, and very glad to be enabled to make others happy; the pleasure derived from the approbation of others, from the approbation of their own minds; the increase of goodwill in the person benefited; and the accordance with all the religious feelings which are possessed, and with various circumstances less general, add such a stock of pleasurable feelings to the doing good to others, that by degrees it is an object of desire, altogether independently of any consideration beyond itself. A person who has completely gone through this process, desires to benefit others without the slightest reference to his own personal benefit, either in this world or in the next: he employs the different opportunities which present themselves to him of doing good to others, without thinking of any thing more than the immediate object. If it call for great exertion on his part, great efforts of self-denial, he brings to his aid the desire of following the dictates of duty, of obeying the commands of God, and where his benevolence, his love of duty, and his love of God, are thoroughly purified from self; to do good he will forego great and any pleasures, and endure great and any pains, without a thought beyond the attainment of the good which he produces, and the obedience to the claims of God and duty. Is he not now a noble being, worthy the discipline which his heavenly father hath bestowed upon him? And would not any one, to attain this height, go through any correction or trial? A less height is often observed. Benevolence may, with the strictest propriety, be termed disinterested, when, in a considerable number of its promptings, it has no end beside the good which it proposes, and this is obtained by numbers; and by those who have attained this height, that improvement may be made, by cultivating a general love of duty, and a regard to the will of God, which refutes beyond the possibility of rational controversy, the opinion that every feeling of the human mind is selfish.—We surely need not show how these things illustrate and explain the law of transference, by which, means become the ends. We shall, however, just point out that the desire of doing good itself may sometimes be lost from the view of the mind in attention to the means of doing it. Some of our readers are probably considerably interested in the welfare of institutions for the promotion of the welfare of the poor and afflicted; these institutions were planned by benevolence, and benevolence prompts their support. It is the desire of doing good which has led to the frequently returning exertions which are made to keep them in vigour; but we have no doubt but the welfare of one or other of those institutions will often be found to be an object of the mind without reference to the good it does. The mind rejoices in its success, without thinking of the benefit which will result from it. As soon as the attention is directed to the benefits, the mind dwells upon them as the ultimate reason of its pleasure; but that was not in the view of the mind. Whether we have been successful or not in making our readers feel the force of the assertion by this illustration, we are confident of the fact, that the means of doing good often themselves become ends; and that the desire of their successful furtherance, which

was originally felt for them, merely on account of the good they promised or did, is at last felt without reference to that good; though, on the other hand, it would by degrees, though perhaps not very soon, decay, if it were proved to the satisfaction of the mind, that the means of the hoped-for good were and must be totally inefficacious.—But there would be no end to illustrations of this law, if we were to trace it out in all its operations. We are continually loving things because—and afterwards loving them for themselves alone: it extends to the love of duty in general, without any reference to those peculiar branches of it with which we have been more immediately concerned. All the pleasurable feelings arising from particular branches of duty, and all the tendencies to particular branches of duty, by degrees become connected with the idea of duty in general, which is, in fact, formed of all the ideas of particular branches, &c. which we have considered as right and our duty; hence duty becomes an object of desire, because parts of it are loved on their own account, and this hastens the progress of a disinterested love of duty in general. But leaving this out of the question, a great variety of considerations make it an object of choice; and if it be pursued as a mean to obtain the object in view, with sufficient steadiness, and for a sufficient length of time, by degrees it is pursued as an end, and duty is then loved for itself.

46. We shall think ourselves fortunate if we have succeeded in giving a distinct idea of the progress of the mind from self to disinterestedness. There are few things in mental investigations more interesting, or of greater practical value, than the tendency to love and to desire to promote things which have no immediate connection with our own good, without any reference to our own good.—That the human mind is capable of gross selfishness which defies all present discipline to correct, is a fact which cannot be denied, and which should excite our vigilance and concern. But it is no less a fact, that it is also capable of disinterestedness which shall run through the whole of the conduct, and prompt uniformly and steadily to the promotion of others' welfare. The earliest pleasures are personal; I wish not to call them selfish, because we seem to appropriate that term to those feelings which have an explicit reference to our own real or imaginary good, and which prompt to this even at the expense of others; in this sense the human mind cannot with the least propriety be said to be originally selfish; but its earliest pleasures are personal, and its earliest desires are consequently personal. Its interest in the pleasures of others, arises from their connection with the personal pleasures; and consequently the desire of promoting their pleasures, the love of others, is originally interested; that is, it is in consequence of its personal pleasures depending on the pleasures of others. There is nothing criminal in this, it is according to the laws of our mental frame; it is only criminal when the mind rests here; for it cannot, without being wrongfully impeded. The good of others promotes our personal pleasures, and hence it is originally that we desire to promote their good. By degrees the desire is transferred completely from the original end, personal pleasures, to the good of others, the original means, and then this becomes an end and the desire is disinterested.

47. We feel the glow of pleasure in thus tracing the progress of the mind, and shewing that its tendency is to disinterestedness, and that it is often obtained in a comparatively universal extent. Let us not then listen to the degrading ideas of those who would persuade us that the most perfect benevolence is only the most refined selfishness; that all which is said by philosophers and moralists respecting disinterestedness is unmeaning rant, and that, when we call upon mankind to divest themselves of self and personal considerations, we call upon them for something which they are not able to practise. We may, with the consistency of truth, have a nobler view of our species; and we may ourselves hold up, as the object of our steady exertions, that state of mind, in which to perceive the practicable means of promoting the good of others, and to employ them, will be invariably associated, without any connecting intervening bond of union.—On the other hand, let no one less highly value the exertions of disinterestedness because it can be shewn to arise from a meaner origin. Ought we not rather to admire the height which has been gained by a steady use of the general means of worth, and by a right employment of the discipline of Providence? Is his conduct less lovely who has gone through the trial, and brought from it disinterestedness which prompts to efforts of the noblest kind for the good of others? The original disinterestedness

of the mind may be pleasing in some points of view; but in others it is the contrary; it diminishes the worth of character in those cases where it exists, for constitutional disinterestedness has no more merit than the possessions of a good sight; and it damps too the efforts to obtain disinterestedness. Those who find themselves deficient, who discover feelings which disinterestedness owns not, have, on the theory here proposed, the best encouragement, the prospect of success, in their endeavours to transfer their affections from self. It leads too, humbly and gratefully, to acquiesce, in every means which Providence may appoint, to discipline the mind, and to purify it from all that can debase. In short, it points the view to the highest excellence, and directs the means of attaining it.

4. *Habitual Biases.*

48. We now proceed to the last of those laws of association, which we propose to notice, and in what we shall advance on the subject, we shall make a free use of Stewart's Elements.—The leading feature of the operations of the associative power is that when two or more ideas, &c. are presented to the mind, together or in close succession, they become connected with one another, or blended together, so that the one when recalled to the view of the mind, is accompanied with the other. But we must not limit its exercise to this operation; it not only connects ideas when they are thus presented together to the mind, but is the cause of the introduction of ideas with one another, which have never before been presented together to the mind. An object which has never before been presented to the mind, may excite numerous ideas, or trains of ideas; while another may continually occur without exciting a single idea. And the same object will affect different persons differently, so that in the mind of one it will excite trains of thought, while in another it will only produce a momentary impression; and in different persons too the same object will excite different trains of thought; and in the same person, at different times, different effects will be produced.—Now all this depends upon the habitual or accidental biases to particular kinds of connection, produced either by the habitual tendency of the mental constitution, or more usually by the particular culture of the individual mind, owing to direct instruction, or to the effect of circumstances, operating without any intention either on his part or on that of others.

49. The earliest bond of union between objects of thought, is their being presented to the mind together, or in close succession, through the medium of sensation; this is owing to the objects of sensation being connected either in time or place, or in other words, owing to the relation of contiguity in time and place existing between these objects. This cause of connection among our ideas is what necessarily has the earliest efficacy in forming those connections, because it does not presuppose, as every other does, the existence of other ideas in the mind, or the exercise of attention to other relations which exist among them. Children associate ideas together almost entirely by this bond of union; persons of uncultivated minds in the same manner, usually have their ideas connected by the same bond of union, contiguity of time and place of the objects of sensation, producing impressions on the mind at the same time, or in close succession; and more or less it is a connecting link, or cause of connection, in every one, in every period of life. We might, *à priori*, calculate upon its high importance in the mental structure, and as a matter of fact, it is the foundation of all experience and philosophy, and at the same time the source of numerous prejudices. It is the source of numerous prejudices, by leading us to expect continued conjunction in time or place, where the conjunction was only occasional, and thus to suppose a real and permanent connection between objects which had only an accidental and temporary connection. Hence unenlightened experience of the past will fill the mind, in numberless instances, with vain expectations, or with groundless alarms, concerning the future; hence the regard which is paid to unlucky days, to unlucky colours, to the influence of the planets, &c.; apprehensions which render human life, to many, a continual series of absurd terrors. But this principle of connection among our ideas is also the foundation of all experience and philosophy; for the grand object of philosophy is the knowledge of those laws which regulate the succession of events, so that from the past we may be enabled to anticipate the probable course of the future, and to regulate our conduct accordingly; and therefore it is of the first importance that the connections of time and place should have a strong power over the mind. Experience is of a more limited nature, but has the same ob-

ject to anticipate the probable course of events, so as to make the past subservient to the conduct of the future; and by rendering contiguity, in time, one of the strongest principles of connection in our minds: the wise Author of our frame has conjoined in our thoughts the same events which we find conjoined in our experience, and has thus accommodated (without any effort on our part) the order of our ideas to that scene in which we are destined to act.

50. Upon the connections established by this principle, all other connections are founded. Some of the most striking are those which arise from the relations of similarity, of contrariety, of cause and effect, of means and end, of premises and conclusion. Next to the relation of contiguity in time and place, that of similarity is most universally operative. It does not depend upon an active exertion of intellect, but arises spontaneously from the mental constitution. Similarity implies partial identity of sensation, and hence an object, when first presented to the mind, frequently recals the idea of that which has some parts of its component sensations the same. Thus when we see a face which considerably interests us, we are often led to recollect the face of some other person, in consequence of the impressions from each agreeing in some particulars. In the same manner, where the circumstances of one event are, in some respects, the same with the circumstances of another, which had before fallen under our notice, so far there is a recurrence of the same impressions, and that by the more general law of association recals the remaining circumstances.—This cause of connection among our ideas, like that of contiguity in time or place, is of the greatest importance, and at the same time liable to be greatly misused. Without it the experience of the past would be of no utility to us, for the same set of circumstances never occurs twice; if there be sufficient similarity to recal the past, it now answers the purpose of exciting the expectations of what occurred in similar circumstances, that is, of bringing the experience of the past to bear upon the present. But as similarity is only partial sameness, if it be not accompanied with some discrimination, consequences will be expected that will never happen, and conclusions, which will mislead, will be formed without any just foundation.—Ideas are connected together not only in consequence of similarity, that is sameness in some of their component parts, but frequently also from similarity in the sounds expressing them. It is upon this circumstance that the art of punning is founded; an art which may be innocent in itself considered, but which, when made an object of the mind, leads from sense to sound, and prevents us from carefully examining the arguments and differences of things, on which alone reasoning can be founded. So much, indeed, is a habit of punning at variance with habits of thought and sober reflection, that the whole current of thought will sometimes be diverted from its proper channel, by some word in which the thought is expressed, recalling, by similarity of sound, some other which calls up its own train of thought. A good pun may sometimes be considered as an exercise of the judgment; but more usually it is merely an exercise of the associative power, in this particular principle of connection, similarity in sound; and therefore it would be wise in young persons to check the desire to obtain an acquisition which is of little value, because almost every one may acquire it, and which must check the culture of other more valuable principles of association.

51. Another fertile principle of connection is contrariety, which connects together ideas which are totally, or in many respects, opposite to each other. This, however, is more the result of attention and habit than those of contiguity in time or place, and similarity. Some persons are particularly disposed to it, others have little tendency to it. It frequently appears to arise from the natural tendency of the mind to change from one set of feelings, which are in some way or other displeasing, to others which may be pleasing; and very often serves to illustrate reasoning; but particularly to give interest and force to a description of natural scenery, or a delineation of character.

52. The other principles of connection which we mentioned are more refined, and are the result of culture. A person who has been more accustomed to philosophize, or to reason, than to follow the airy flights of wit or poetic fancy, connects his ideas by the principles of cause and effect, of means and end, of premises and conclusion. When a phenomenon is stated to his mind, it almost involuntarily brings forward ideas which serve to account for the phenomenon: we do not mean, that the mind invariably brings forward the right ideas, but simply those which answer the wants of the individual, by serving to account to him for the phenomenon. So, in the same manner,

when an end is proposed, the train of thought is concerned about the means, which are often suggested, though the object itself was never before in the view of the mind. All these relations doubtless produce their effect by minute and almost imperceptible samenesses in the particular object now in the view of the mind, and some one which before has been, and has been connected by some cause or other with the cause or means by which it was produced, or to be produced; but it is convenient to speak of them as distinct from the more obvious relations, because they imply different culture of the mind, and lead to such widely different effects.—Now any one of these connecting principles may by habit be strengthened to such a degree as to give us a command over all the different ideas in our mind which have the given relation to each other; so that when any one in the class occurs to us, we have almost a certainty that it will suggest the rest.—As this appears to be an indisputable fact respecting the influence of association, we may state it in the following general form:—When an idea is presented to the mind, either by sensation or by association, bearing certain relations, either in itself, or in its effects on the mind, with another idea already on the mind, the latter is recalled by the former, and becomes connected with it: and the association thus produced is subject to the same laws with those formed, owing to the contiguity in the times of the reception of the ideas.

RESPECTING THE COMPOSITION OF IDEAS.

53. Another grand law, or mode of operation, of the associative power, is that by which simple ideas are formed into compound, or complex ideas; in other words, more generally, by which simple sensorial changes are combined and blended together.—In the consideration of this law, we shall derive most of our statements from those of Hartley, divesting them however of those peculiarities of expression, which depend for their correctness upon the truth of the positions, that the medullary substance of the brain is the sensorium, and that sensorial changes are vibrations of the medullary substance. In order to explain this law of association, it is necessary to take a view of the modes in which simple ideas, or ideas of sensation, may be associated.

Case 1. Let the sensation A be often associated with each of the sensations B, C, D, &c.; that is, at certain times with B, at certain other times with C, and so on: it is evident from what has been before stated (§ 21.) that A, when produced alone, will raise *a*, *b*, *c*, *d*, &c. (the simple ideas of sensation corresponding respectively with A, B, C, D, &c.) altogether, and consequently will associate them together. If *a*, *b*, *c*, *d*, &c. are distinct in all their parts, then, in the first instance they will be merely connected, so as to make a group (which may be represented by $a+b+c+d$;) but if they are not distinct in their parts, they more or less run into each other, so as to form a complex cluster, (which may be represented by *abcd*.) Now the more frequently the group $a+b+c+d$, &c. occurs in connection, the more closely the single ideas are united; and unless any one has a peculiar degree of vividness, they will by degrees appear to the mind as one idea; and unless the notice of the mind is particularly directed to the circumstance that it is composed of parts, it appears as much a single idea as originally each of the parts would have done, if the attention had been directed to them singly. Again, the more the cluster *abcd*, &c. occurs in combination the more completely the parts coalesce, so that by degrees they form a complex idea, the parts of which are scarcely distinguishable.

54. Case 2. If the sensations A, B, C, D, &c. be associated together, according to various combinations of twos, or even of threes, fours, &c. then will A raise up $b+c+d$, &c.; also B will raise up $a+c+d$, &c.; and compound or complex ideas will be formed of those combinations, precisely as was before stated in the case of sensations singly associated with another sensation. It may happen indeed in both cases, that A may raise a particular idea as *b*, preferably to any of the rest, in consequence of its being more frequently associated with *b*, or of the greater novelty of the impression of the corresponding sensation, B, rendering it more vivid, or of some tendency of the sensorium to excite *b*, or of some other cause; and in like manner that B may raise *c* or *d* preferably to the rest. However, all this will at last be over-ruled by the recurrence of the associations, so that any one of the sensations will excite the ideas of the rest at the same instant, and therefore associate them together.

55. Case. 3. Let A, B, C, D, &c. represent successive sensations (occurring in contiguous, successive instants,) A will raise

b, *c*, *d*, &c. B will raise *c*, *d*, &c.: and though the ideas do not rise precisely in the same instant, yet they come nearer and nearer together than the sensations did in their original impression; so that these ideas are at last associated synchronously as they were from the first successively.

56. Case 4. All compound impressions, A + B + C + D, &c. or A B C D, &c. (according as they are received by different organs, or the same) after sufficient repetition leave behind their compound ideas *a* + *b* + *c* + *d*, &c. or *abcd*, &c. which recur every now and then by means of sensations, or ideas, with which the whole compound, or any one or more of the parts A, B, C, D, &c. have been associated. Now in these recurrences of compound ideas, the parts are further associated, and more intimately united to one another, agreeably to what was observed above, so as to form a compound or complex idea which shall appear to the mind as one single idea.—As the same causes produce the recurrence of the compounded ideas, in whatsoever way the union was first produced, the same remark may be made under each of the cases as have been under this and the first case, respecting the causes and effects of such recurrence.

57. On the whole it may appear to the reader, that the simple ideas of sensation must run into clusters and combinations, by association; and that each of these will, at last, coalesce into one compound or complex idea. It appears also from observation, that many of our mental or intellectual ideas (that is those in which no particular idea of sensation is perceptible) such as those which belong to the heads of beauty, honour, moral qualities, &c. are, in fact, thus composed of parts which by degrees coalesce into one complex idea. And as this coalescence of simple into complex ideas is thus evinced, both by the theory of association and by observation, so it may be illustrated and further confirmed, by the similar coalescence of letters into syllables and words, in which association is likewise a chief instrument.

58. If the number of simple ideas which compose the complex idea be very great, it may happen that the complex ideas shall not appear to bear any relation to its component parts, nor to the external senses by which the original sensations were received. The reason of this is, that each single idea is overpowered by the sum of all the rest, as soon as they are all intimately united together. Thus in very compound medicines, the several tastes and flavours of the separate ingredients are lost and overpowered by the complex one of the whole mass: so that this has a taste and flavour of its own, which appears to be simple and original. Thus also white appears, and is vulgarly thought to be, the simplest of all colours, while yet it really arises from a certain mixture of the seven primary colours in their due shades and proportions. And to resume the illustration above mentioned, to one unacquainted with the arts of reading and writing, it could not appear probable, that the great variety of complex sounds in language are to be analysed into a few simple sounds. One may hope, therefore, that by pursuing and perfecting the doctrine of association, we may some time or other be enabled to analyse all that vast variety of complex ideas which pass under the names of ideas of reflection, abstract ideas, desires, affections, &c. into their simple component parts, that is, into the simple ideas of sensation of which they are formed. This would be greatly analogous to the representation of complex articulate sounds by alphabetical signs, and to the revolution of colours, or of natural bodies, into their simple constituent parts. The complex ideas here spoken of are generally excited by words or visible objects; but they are also connected with other external impressions, and depend upon them as symbols. In whatever way we consider them, the trains of them which are presented to the mind, seem to depend upon the then present state of the body, the external impressions and the remaining influence of prior impressions and associations taken together.

59. As simple ideas of sensation run into complex ones by association, so complex ideas run into decomplex ones by association. But here the varieties of the associations, which increase with the complexity, hinder particular ones from being so close and permanent between the complex parts of decomplex ideas, as between the simple parts of complex ones.

60. The simple ideas of sensation are not all equally and uniformly concerned in forming complex and decomplex ideas, but on the contrary some occur much oftener than others; and the same holds good of complex ideas as the component parts of decomplex ideas: and innumerable combinations never occur at all in real life, and

consequently are never associated into complex and decomplex ideas. Just as in languages, some letters, and combinations of letters, occur much more frequently than others, and some combinations never occur at all.—Further, as persons who speak the same language have, however, a different use and extent of words, so, though mankind in all ages and nations agree, in general, in their complex and decomplex ideas, yet there are many particular differences in them, and these differences are greater or less, according to the difference or resemblance in age, constitution, education, profession, country, period, &c. that is, in their impressions and associations.

61. When sensations and ideas, with their most common combinations, have been often presented to the mind, a train of them, of considerable length, may, by once occurring, produce such a tendency to recurrence, that they may recur, without the previous cause, in nearly the same order and proportion as in this single occurrence. For since each of the particular sensations and ideas is familiar, little more will be wanting for their recurrency than a few connecting links; and even these may, in some instances, be supplied by former similar instances. These considerations, when duly unfolded, seem to explain the chief phenomena of memory; and it will be easily seen from them, that the memory of adults, and of proficients in any science, ought to be much more ready and certain than that of children and novices, as it is found to be in fact.

62. As many words have complex ideas annexed to them, so sentences, which are collections of words, have collections of complex ideas, that is, have decomplex ideas. And it happens in most cases, that the decomplex idea belonging to any sentence, is not compounded merely to the complex ideas belonging to the words of it; but that there are also many variations, some oppositions, and numberless additions. Thus propositions, in particular, excite, as soon as heard, assent or dissent; which assent or dissent consist chiefly of additional complex ideas not included in the terms of the proposition. And it would be of the greatest use both in the sciences and in common life, thoroughly to analyse this matter, to show in what manner, and by what steps, that is, by what impressions and associations our assent and dissent, both in scientifical and moral subjects, is formed.

Respecting the Viridness of complex Ideas, and the intellectual Pleasures and Pains in general.

63. It is reasonable to think that some ideas may be as vivid as any sensation excited by the direct action of objects upon the external organs of sense. For complex ideas may consist of so many parts, and these may so alter and exalt one another, that the sensorial change (whatever that be), may be as great as can be produced by any single external impression. And we know as a matter of fact that mental pains are sometimes so acute as to counterbalance, and even altogether remove, the attention from the most excruciating pain, which is merely that of sensation. This process may be assisted and accelerated by the mixture of vivid sensations among the ideas, by the sensibility of the mental frame, by a predisposition to a particular class of ideas, &c. —It is on this principle, in connection with the preceding statement, that we are enabled to account for the existence of intellectual or mental pleasures and pains (that is, those in which no particular sensible pleasure or pain is perceptible), which form a distinct and a most important class of feelings. The quality of sensible pleasures or pains, that is, of pleasurable or painful sensations, unite and coalesce in the same manner as other ideas; and variously connected and blended together, they constitute the whole of those internal feelings which we call passions, affections, emotions, &c.—In almost every step of our investigations in mental philosophy, we are perplexed by the scantiness of language, and still more by the want of precision with which the words we have are employed. It is much more easy to point out faults than to correct them; but it appears to us likely to promote the object in one department, if the two classes of ideas (the relicts of sensations), viz. those which are pleasureable or painful, and those which are indifferent, or, more properly, which belong to the understanding, were denominated the latter notions, the former feelings. Popular language would, in a great measure, have borne us out in this appropriation; but, at least in the commencement of our statements, we were obliged to employ feelings in a more general sense, viz. for every sensorial change attended with consciousness, because we have no other word in the language comprehending ideas and sensations: henceforwards, however, we wish to appropriate

the word feelings to those complex ideas which are either pleasureable or painful, so as to correspond with Hartley's denomination "intellectual or mental pleasures and pains," including, as he appears to do, the affections and passions.

64. It appears from the preceding section, that the mental pleasures and pains may be equal to, or greater or less than, the sensible ones, according as each person unites more or fewer, more vivid or more languid ideas in the formation of the mental pleasures and pains.

65. It is of the utmost consequence to morality and religion, that the feelings should be analysed into their simple component parts, by reversing the steps of the associations which concur to form them. For thus we may learn how to cherish and improve good ones, to check and root out such as are mischievous and immoral, and how to suit our manner of life, in some tolerable measure, to our intellectual and religious wants. And as this holds, in respect of persons of all ages, so it is particularly true and worthy of consideration in respect of children and youth. The world is, indeed, sufficiently stocked with general precepts for this purpose, grounded on experience; and whosoever will follow these faithfully may expect good general success. However, the doctrine of association, when traced up to the first rudiments of understanding and affection, unfolds such a scene as cannot fail both to instruct and alarm all such as have any degree of interested concern for themselves, or of a benevolent one for others.

66. Our original bodily structure, and the impressions and associations which affect us in passing through life, are so much alike, and yet not the same, that there must be both a great general resemblance among mankind in respect of their mental pleasures and pains, and also many particular differences.

67. Some degree of spirituality (that is, that state of mind in which the pleasures and pains are not sensible), is the necessary consequence of passing through life. The sensible pleasures and pains must be transferred by association more and more every day, upon things which of themselves afford neither pleasure nor pain.

68. Let the letters, a, b, c, d, e, &c. represent the sensible pleasures, and x, y, and z, the sensible pains, supposing them to be only three in number; and let us suppose all these, both pleasures and pains, to be equal to each other in degree. If now the ideas of these sensible pleasures and pains be associated together, according to all the possible varieties, in order to form intellectual pleasures and pains, it is plain, that pleasure must prevail in all the combinations of seven or more letters; and also, that when the several parts of these complex pleasures are sufficiently blended by association, the pains which enter into their composition will no longer be distinguished separately, but the resulting mixed and complex pleasures will appear to be pure and simple ones, equal in quantity to the excess of pleasure above pain, in each combination. Thus association would convert a state in which pleasure and pain are both perceived by turns, into one in which pure pleasure would alone be perceived; at least would cause the beings who were under its influence to any indefinite degree, to approach to this last state nearer than by any definite distance. Now though the circumstances of mankind are not the same with those here supposed, yet they bear a great resemblance to them, during that part of our existence which is exposed to our observation; for our sensible pleasures are far more numerous than our sensible pains; and though the pains are in general greater than the pleasures, yet the sum total of the latter is probably greater than that of the former; whence the remainder, after the destruction of the pains by the opposite and equal pleasures, will be pure pleasure.

69. The intellectual pleasures and pains are as real as the sensible ones, being, in fact, nothing but the sensible pleasures and pains variously mixed and blended together. They are also all equally of a factitious and acquired nature; and we must therefore estimate all of the pleasures equally, by their magnitude, permanency, and tendency to produce others; and the pains in like manner.

Of the Affections and Passions.

70. Affections, passions, and emotions, may be considered as the re-action of the mind towards those objects which directly, or indirectly, produce pleasure or pain. Supposing that by association a very complex, pleasurable feeling has been so connected with any object, as to be excited by the sensation or idea of that object, by degrees the object is considered as the source of that feeling, and the pleasurable feeling

blended with the idea of the object, being the indirect or immediate source of it, is called love; the contrary feeling, produced by contrary associations, is called hatred. (We do not here speak of the particular modifications of these feelings, or of their restrictions, but of the general feelings excited in our minds by objects causing, or supposed to cause, pleasurable or painful feeling). When either of them, (the love, for instance,) is habitually connected with any object, it is called an affection for that object; and all its various modifications, however, and in whatever degree produced, if they are more than the ebullitions of the moment, being permanent feelings ready to be excited by the appropriate object in appropriate situations, are also termed affections. If from any strength in the exciting cause, or peculiar sensibility of the frame, or peculiarly vivid associations, connected with objects of a specific cast, that cause or produce a vivid excitement of feeling, which (though it may last perhaps for a considerable time, if not excessive in degree), gradually loses its vividness, and altogether ceases, or settles down into a more permanent, but less active feeling, that vivid, vigorous feeling is denominated a passion. The mind may have such a predisposition to a certain set of passions, that these may be easily excited, and by every such excitement increase the predisposition to future excitement, and add to the strength and vividness of the more permanent corresponding affections, but the excitement itself, and its effect, the passion, cannot, from the nature of the mind, last long. From this account it may appear, that the passions and affections differ from each other principally in their degree and duration. There is a third class of feelings, which may more properly be called emotions, than either passions or affections; where the pleasurable or painful feelings are not explicitly referred to the exciting cause; and have not that vividness and strength which is essential to a passion: they are states of pleasure or of pain, following the excitement of some affection, and generally accompanied or blended with trains of conceptions and thoughts. We are aware that we do not use this term in the sense in which Dr. Cogan professes to employ it; but we doubt, whether in this instance the usual penetration and accuracy of that philosopher have accompanied him; and as it appears to us, his own use of it is essentially different from that given in his definition, in which he confines it "to the external marks or visible changes produced by the impetus of the passions upon the corporeal system." A tendency to the exercise of affections, and to the excitement of emotions or passions, is called a disposition: in these cases in which the disposition is habitual, and regulates a considerable proportion of the affections or passions, it seems appropriately termed the temper.

71. Respecting the classes of affections, passions, and emotions, we must not here enlarge. It is a most copious and difficult subject; and, as pursued with different objects, different classifications appear preferable. Supposing the object to be, to take these feelings as they are, and to arrange them so as to show their relationship, and tendency to affect one another, having in view the phenomena rather than the causes of them, we should be led to give a decided preference to the elegant arrangement of Dr. Cogan, in his very valuable work on the passions; but if it be to trace them to their sources, in order to show how they are formed, directly or indirectly, of the relicts of sensations, and modified by the various combinations of them, which is an object of the greatest importance, as has been already observed, Dr. Hartley's arrangement, even if somewhat deficient in philosophical accuracy, as perhaps Dr. Cogan has shown, must have the preference, having been founded on that object. The arrangement of Dr. Cogan is by himself stated as follows: "When the nature of the exciting cause is more accurately ascertained, it will be found to respect either the selfish or the social principle. Hence arise two important distinctions, forming two different classes. In each class, the predominant idea of a good, and the predominant idea of an evil, will constitute two different orders. The leading passions and affections under each order, point out the genera. The complicated nature of some of the passions, and other contingent circumstances, may be considered species and varieties under each characteristic genus." Dr. Hartley's arrangement is two-fold: first, the passions and affections in general; secondly, the passions and affections, as excited by the different classes of intellectual pleasures and pains. Respecting the latter, we shall have an opportunity of speaking under the different classes: we shall here briefly state the arrangement of the general passions and affections. As all the passions and affections arise from pleasure

and pain, the first and most general distribution is into love and hatred. When these are excited to a certain degree, they stimulate us to action, and may then be termed desire, or aversion, understanding by the last word, active hatred. Hope and fear arise from the probability or uncertainty of obtaining the good desired, or of avoiding the evil shunned. Joy and grief are love or hatred exerted towards an object when present, so as to occupy the whole attention of the mind. After the actual joy or grief is over, and the object withdrawn, there generally remains a pleasing or displeasing recollection, which recurs with every recurrence of the idea of the object, or of the associated ones, and keeps up the love or hatred. These ten; five grateful, and five ungrateful, passions or affections, Dr. Hartley considers as comprehending all the general passions of human nature.

OF THE CLASSES OF INTELLECTUAL PLEASURES AND PAINS, WITH A SPECIFIC ACCOUNT OF THEIR ORIGIN.

72. The intellectual pleasures and pains are arranged by Hartley in six classes. Perhaps the arrangement, and certainly the appellations of the classes, are not unexceptionable; but so much light is thrown upon this part of our mental structure by the analysis of them given by Hartley, and it is so much easier to find fault than to improve, that we shall probably do best by taking the arrangement and (with a few passing remarks) the appellations as we find them, and by laying before our readers such a specimen of the analytical investigations of that profound philosopher, as may lay a solid foundation for correct notions on this important point, and lead them to seek for further information in his observations.—The intellectual pleasures and pains are, 1. Those of imagination, arising from natural or artificial beauty or deformity. 2. Those of ambition, arising from the opinions of others concerning us. 3. Those of self-interest, arising from the possession or want of the means of happiness, and security from, or subjection to, the hazards of misery. 4. Those of sympathy, arising from the pleasures and pains of others. 5. Those of theopathy, arising from the consideration of the attributes of the Deity, and the relation in which we stand to him; and, 6. Those of the moral sense, arising from the contemplation of moral beauty and deformity.

1. *Of the Pleasures and Pains of Imagination.*

73. This class of feelings may be distinguished into seven kinds: the pleasures arising from the beauty of the natural world; those from the works of art; from the liberal arts of music, painting, and poetry; from the sciences; from the beauty of the person; from wit and humour; and the pains which arise from gross absurdity, inconsistency, or deformity.—As the pleasures of the first class admit of the most simple analysis, we shall select this as a specimen.—The pleasant tastes and smells, and the fine colours of fruits and flowers, the melody of birds, and the grateful warmth or coolness of the air in the proper seasons, transfer the relics of these pleasures upon rural scenes, which rise up instantaneously so mixed with each other, and with such as will immediately be enumerated, as to be separately indiscernible. If there be any object in the scene calculated to excite fear and horror, the nascent ideas of these magnify and enliven all the other ideas, and by degrees pass into pleasures by suggesting the security from pain. In like manner the grandeur of some scenes, and the novelty of others, by exciting surprise and wonder (that is, by making a great difference in the preceding and subsequent states of mind, so as to border upon or even enter into the limits of pain) may greatly enhance the pleasure. Uniformity and variety, in conjunction, are also principal sources of the pleasures of beauty, being made so partly by their association with the beauties of nature, partly by that with the works of art, and with the many conveniences which we derive from the uniformity and variety of the works of nature and of art: they must therefore transfer part of the lustre borrowed from the works of nature, and from the conveniences they afford upon the works of nature. Poetry and painting are much employed in setting forth the beauties of the natural world, at the same time that they afford us a high degree of pleasure from other sources: hence they blend some or other of the relics of those other pleasures with those of natural beauty. The many amusements which are peculiar to the country, and whose ideas and pleasures are revived in a faint degree by the view of rural scenes, and so mixed together as to be separately indiscernible, further augment the pleasures suggested by the beauties of

nature. To these we may add the opposition between the offensiveness, dangers, and corruption of populous cities, and the health, tranquillity, and innocence, which the actual view or the mental contemplation of rural scenes introduces; and the pleasures of sociality and affection, which have many connections with them; and those pleasures which the opinions and encomiums of others respecting natural beauties produce in us, in this, as in other cases, by means of the contagiousness observable in mental, as well as in bodily dispositions. It is also to be remarked, that green, which is the most agreeable to the organ of sight, is the most general colour of the vegetable kingdom, that is of external nature; but at the same time with so many varieties, that it loses little or none of its effect in producing pleasure, which it would do if it were all of the same tint. Those persons who have already formed high ideas of the power, knowledge, and goodness of the author of nature, with suitable affections, generally feel the exalted pleasures of devotion upon every view and contemplation of his works, either in an explicit and distinct manner, or in a more secret and implicit one: hence part of the general indeterminate pleasures here considered, is deducible from the pleasures of theopathy.

74. The above may be considered as the principal sources of the beauties of nature to mankind in general. Inquisitive and philosophical persons have some others, arising from their peculiar knowledge and study of natural history, astronomy, and philosophy in general: for the profusion of beauties, uses, fitnesses, elegance in minute things, and magnificence in great ones, exceed all bounds of imagination; and new scenes, and those of unbounded extent, separately considered, ever present themselves to view, the more any one studies and contemplates the works of God. Upon the whole the reader may see that there are sufficient sources for all those pleasures of imagination which the beauties of nature excite in different persons; and that the differences which are, in this respect, found in different persons, are sufficiently analogous to the differences of their situations in life, and of the consequent associations formed in them. Those who are closely attentive to what passes within them, may also, when contemplating the beauties of nature, frequently discern the relicts of many of the particular pleasures here enumerated, while they recur in a separate state, and before they coalesce with the general indeterminate aggregate, and this verifies the account here given. It is also a confirmation of it, that an attentive person may observe great differences in the kind and degree of the relish which he has for the beauties of nature in different periods of his life; especially as the kind and degree will be found to agree in the main with the foregoing account. To the same purpose it may be observed, that these pleasures do not cloy very soon, but are of a lasting nature when compared with the sensible ones; since this follows naturally from the great variety of their sources, and the evanescent nature of their constituent parts.

2. *Of the Pleasures and Pains of Ambition.*

75. The opinions of others concerning us, when expressed by corresponding words or actions, are principal sources of happiness or misery. The pleasures of this kind are usually referred to the head of honour, the pains to that of shame. We are here to inquire by what associations it is brought about, that men are solicitous to have certain particulars concerning themselves made known to the circle of their friends and acquaintance, or to the world in general; and certain others concealed from them: and also, why all indications that these kinds of particulars are made known, so as to produce approbation, esteem, praise, &c. or dislike, censure, contempt, &c. occasion such exquisite pleasures as those of honour and shame.—These particulars may be classed under four heads: external advantages or disadvantages; bodily perfections and imperfections; intellectual accomplishments and defects; moral ones, that is, virtue or vice. We shall, as before, select the analysis of one of these classes of the feelings of ambition.

76. The intellectual accomplishments and defects which occasion the feelings of ambition, are, sagacity, memory, invention, wit, and learning; and their opposites, folly, dulness, and ignorance. Now, it is evident, that independent of the intrinsic value of the former class, and disadvantage of the other, the circumstance of their being made known to others, respectively produces certain privileges and pleasures, or subjects to inconveniencies and pains. It follows, therefore, that every discovery of this kind to others, also every mark or associate of such discovery, will, by association, raise

up the relicts of those privileges and pleasures, or inconveniencies and pains respectively; and these being gradually blended together, and united with those with which each repetition of the producing cause is accompanied, afford in each instance a peculiar compound pleasure or pain, which, by the custom of our language, has the word honour or shame respectively connected with it. The general account will apply to each of the four classes of the feelings of ambition; but the feelings of honour or shame connected with this particular class, require a more minute analysis. A great part, perhaps the greatest, is derived from the high-strained encomiums, applauses, and flatteries, paid to talents and learning, and the outrageous ridicule and contempt thrown upon folly and ignorance, in all the discourses and writings of men of genius and literature; these persons being extremely partial to their own excellencies, and carrying the opinion of the world along with them by the force of their abilities and eloquence. It is also to be observed, that in the education of young persons, and especially of boys and young men, great rewards are conferred in consequence of intellectual abilities and attainments, and great punishments follow negligence and ignorance; which rewards and punishments, being respectively associated with the words expressing praise and censure, and with all their other circumstances, transfer upon praise or censure compound vivid relicts of those pleasures and pains.

77. In like manner, all the kinds of honour and shame, by being expressed in words and symbols which are nearly related to each other, enhance each other; thus, for instance, the caresses which are given to a child when he is dressed in fine clothes, prepare him to be much more affected with the caresses and encomiums bestowed upon him when he has been diligent in getting his lesson: and, indeed, it ought to be remarked, that the words and phrases of the parents, governors, superiors, and attendants, have so great an influence over children, when they first come to the use of language, as instantly to generate an implicit belief, a strong desire, or a high degree of pleasure. Unless very improper treatment has been practised, they have at that early period no suspicions, jealousies, recollections, or expectations, of being deceived or disappointed; and therefore a set of words expressing pleasure of any kind which they have experienced, put together in almost any manner, will raise up in them a pleasurable state, and the opposite words a painful one. Whence it is easy to see, that the language expressing praise or blame, must instantly form the mere associations connected with the separate words, put them into a state of hope and joy, or of fear and sorrow. And when the foundation is thus laid, praise and blame will keep their influences from the advantages and disadvantages attending them, though the separate words should lose their particular influences, as they manifestly do in our progress through life.

78. The honour and shame arising from intellectual accomplishments, do often, in learned men, after some time, destroy, in a great measure, their sensibility in respect of every other kind of honour and shame; which seems chiefly to arise from their conversing much with books and learned men, so as to have a great part of the pleasures which they receive from such intercourse, closely connected with the encomiums on abilities and learning, and to hear all terms of honour applied to them, and the keenest reproach, and the most insolent contempt, cast upon the contrary defects. And, as the pleasures which raillery, ridicule, and satire, afford to the by-standers, are very considerable, so the person who is the object of them, and who begins to be in pain upon the first slight marks of contempt, has this pain much enhanced by the contrast, the exquisiteness of his uneasiness and confusion rising in proportion to the degree of mirth and insolent laughter in the by-standers; so that it happens that very few persons have courage to stand the force of ridicule, but rather subject themselves to considerable bodily pains, to losses, and to the anxiety of a guilty mind, than appear foolish, absurd, singular, or contemptible to the world, or even to persons of whose judgment and abilities they have a low opinion.

Of the Pleasures and Pains of Self-Interest.

79. Self-interest may be distinguished into three kinds: gross self-interest, or the pursuit of the means whereby the pleasures of sensation, imagination, and ambition, are to be obtained, and their pains avoided; refined self-interest, or the explicit, deliberate, seeking for ourselves of the pleasures of sympathy, theopathy, and the moral sense, and a like explicit endeavour to avoid their pains; and, rational self-interest, or the explicit pursuit of our greatest happi-

ness without any partiality to any particular kind of happiness, or direct or indirect means of happiness.

80. The love of money may be considered as the chief species of gross self-interest; and, in an eminent manner, assists in unfolding the mutual influences of our pleasures and pains, with the factitious nature of our intellectual ones, and the doctrine of association in general, as well as the particular progress, windings, and endless redoublings of self-love. For, it is evident at first sight, that money cannot naturally and originally be the object of our faculties: no child can be supposed to be born with a love of it; yet we see, that some small degrees of this love rise early in infancy; that it generally increases during youth and manhood; and that at last, in some old persons, it so engrosses and absorbs all their passions and pursuits, as that from being considered as the representative, standard, and means of obtaining the commodities which occur in real life, it shall be esteemed the adequate symbol and means of happiness in general, and the thing itself, the sum total of all which is desirable in life. But we have already said so much on the origin and progress of this affection (§ 45), that we shall only here attend to the checks which, in the course of life, usually prevent the love of money from acquiring that power which, without such restraint, would overcome all the particular desires on which it is founded.

81. First, then, it is checked by the strong desires of young persons, and others, after particular gratifications; for these desires, by overpowering their acquired aversion to part with money, weaken it gradually, and consequently weaken the pleasure of keeping it, and the desire of obtaining it, all which are closely connected together in this view; notwithstanding that the last, viz. the desire of obtaining, and consequently (in an inverted order) the pleasure of keeping, and the aversion to part with, are in another view strengthened by the desires of particular pleasures to be purchased by money. And this contrariety of our associations is not only a means of limiting certain passions, but it may be considered as a mark set upon them by the Author of nature, to shew that they ought to be limited even in this life, and that they must ultimately be annihilated every one in its proper order.—Secondly, the insignificance of riches in warding off death and diseases, and, in many cases, shame and contempt also, and in obtaining the pleasures of religion and the moral sense, and even those of sympathy, ambition, imagination, and sensation, first lessen their value in the estimation of those who reflect, and afterwards assign to them a very low rank among the means of happiness.—Thirdly, the eager pursuit of any other apprehended source of happiness, such as fame, learning, &c. leaves little room in the mind for avarice, or any other foreign end.

82. These considerations not only account for the limitation set to the love of money, but for the various apparent inconsistencies and pecularities observable in it in different individuals. Thus profuseness with respect to sensual and selfish pleasures, is often joined with avarice; covetous persons are often rigidly just in paying as well as in exacting, and are sometimes generous where money is not immediately and apparently concerned; they have also moderate passions in other respects, and for the most part are suspicious, timorous, and complaisant: and the most truly generous, charitable, and even pious persons, are highly frugal, so as to put on the appearance of covetousness, and even sometimes, and in somethings, to border upon it. We also see why the love of money must in general grow stronger with age, and especially if the particular gratifications, to which the person was most inclined, become insipid or unattainable: why frequent reflections upon money in possession, and the actual viewing of large sums, strengthen the associations by which covetousness is generated: and why children, persons in low life, and indeed most others, are differently affected towards the same sum of money in different forms, gold, silver, notes, &c.

83. The love of money is universally deemed a more selfish passion than the pursuit of the pleasures of imagination, honour, or sympathy; yet all are generated by association from sensible pleasures, having their origin in self: all in their several degrees tend to private happiness; and all are, in certain cases, pursued coolly and deliberately from the prospect of obtaining private happiness by them. The reasons why the love of money has in so peculiar and decided a manner the shame of selfishness connected with it, appear to be as follow. The pleasures which it produces are nearly, and in general, completely of a solitary nature, and shun participation. As far as money is deemed a mean to the accomplishment of some useful purpose, if

ceases to be desired on its own account, and then its pleasing associations are communicable: but the love of money as an end is exclusive to the individual possessor. And in addition to this it is obvious, that in general it is not only confined to the individual, but prevents others from receiving the advantages which it might procure to them. The pleasures of sympathy on the other hand, consist in doing good to others; those of ambition are scarcely attainable in any other way; and those of imagination are both capable of a very extensive communication, and are most perfect when enjoyed in company.—Further, a regard to self frequently recurring must denote a pleasure selfish; so that if any even of the most generous pleasures, and such as at first sight have no immediate relation to self-interest be pursued in a cool deliberate way, not from the mere impulse of present inclination, but from the opinion that it will afford pleasure, they must be referred to self-interest. Now money has scarcely any other relation to pleasure than as an evident means; so that after it has acquired the power of pleasing instantaneously, the intermediate steps and associations must frequently appear; and hence it forces on the mind a more constant reference to its tendency to promote the happiness of the individual possessor. The other pleasures have, in general, a far greater share of indirect associations with previous pleasures, and acquire the power of gratifying, not so much from being the manifest causes of other gratifications, as their most common adjuncts; whereas money is generally the most visible of all the causes.

84. Honour, power, learning, and many other things, are however pursued in part after the same manner, and for the same reasons, as riches, *viz.* from a tacit supposition that the acquisition of every degree of these is treasuring up a proportional degree of happiness, to be produced and enjoyed at pleasure. And the desires of each of these would, in like manner, increase perpetually during life, did they not curb one another by many mutual inconsistencies, or were not all damped by the frequent experience and recollection, that all the means of happiness cease to be so, when the body or mind cease to be disposed in a manner proper for their reception.—It is also worthy of observation, that riches, honours, power, learning, and all other things which are considered as means of happiness, become means to each other in a great variety of ways, thus transferring upon each other all the associated pleasures which they collect from other quarters, and approaching nearer and nearer, perpetually, to a perfect similarity and sameness with each other, in the instantaneous pleasures which they afford when pursued and obtained as ends.—It appears, likewise, that all aggregates of pleasure thus collected by them all, must, from the structure of our frame, and of the world which surrounds us, be made at last to centre and rest upon Him who is the inexhaustible fountain of all power, knowledge, goodness, majesty, glory, property, &c.; so that even avarice and ambition are in their respective ways carrying on his benevolent and all-wise designs. And the same thing may be hoped of every other passion and pursuit; one may hope that they all agree and unite in leading to ultimate happiness and perfection. However they differ greatly in their present consequences, and in their future ones, reaching to certain intervals of time indefinite and unknown to us, and thus becoming good or evil, both naturally and morally, in respect of us and our limited apprehensions, judgments, and anticipations. And yet one may humbly hope that every thing must be ultimately good, both naturally and morally.

4. *Of the Pleasures and Pains of Sympathy.*

85. The sympathetic affections, or those by which we feel when others feel, may be divided into four classes: those by which we rejoice at the happiness of others, those by which we grieve for their misery, those by which we rejoice at their misery, and those by which we grieve at their happiness. Of the first kind, are sociality, goodwill, generosity, and gratitude; of the second, compassion and mercy; of the third, moroseness, anger, revenge, jealousy, cruelty, and malice; and, of the fourth, envy. It is easy to be conceived that association should produce affections of all these four kinds; since, in the intercourses of life, the pleasures and pains of one person are, in various ways, intermixed with, and dependent upon, those of others, so that compounds of their relicts are excited in all the possible ways in which the happiness or misery of one person can be combined with the happiness or misery of another, *viz.* in the four above mentioned.—We have already entered so much at length into the rise and progress of the benevolent affections, (§. 41—47.) that we deem it most expedient to give here the analysis of the third class, those by which

we rejoice at the misery of others, previously stating Hartley's application of the terms above mentioned. Sociality is the pleasure we take in the company and conversation of others, particularly of our friends and acquaintance. Goodwill (or benevolence in its more limited sense) is that pleasing affection which engages us to promote the welfare of others to the best of our power. Generosity is that modification of benevolence which disposes us to forego great pleasures, or to endure great pains for the benefit of others. Gratitude is that modification of benevolence which arises from the past reception of favours, leading to make every practicable return of good to our benefactor.—Compassion is the uneasiness which a man feels at the misery of another. Mercy is compassion exercised towards one who has forfeited his title to happiness, or the removal of misery, by some demerit, particularly against ourselves. —Moroseness is that disposition which leads us to be dissatisfied with the efforts of others for our comforts, to be displeased at their innocent enjoyments, and to feel a pleasure in imposing restraints upon their satisfactions. Anger is a sudden start of passion, by which men wish and endeavour harm to others. Revenge prompts to inflict and rejoice in evil, in return for evil real or supposed. Malice deliberately wishes the misery of others. Cruelty disposes men to take delight in inflicting pain, and in contemplating misery. Jealousy arises from the suspicion of a rival in the affections of a person of the other sex. Envy is the disposition by which we consider the good things possessed by others as a diminution of our own happiness, and grieve at their enjoyment of them.

86. Moroseness, peevishness, severity, &c. are most apt to arise in those persons who have some real or imagined superiority over others, which either magnifies their failures of duty, or at least renders the individual very attentive to such failures. Bodily infirmities and frequent disappointments, by making the common intercourses of life insipid, and enhancing small injuries; delicacy and effeminacy, by increasing the sensibility both of body and of mind with respect to pain and uneasiness; luxury, by producing unnatural cravings, which clash not only with the like cravings of others, but also with the common course and conveniencies of life; and, in short, all kinds of selfishness have the same effects upon the temper. The severe scrutiny which persons sincerely penitent for past departures from duty make into their own lives, and the rigid censures which they pass on their own actions, are often found in proud and passionate tempers, to raise such indignation against vice as breaks out into an undue severity of language and behaviour with respect to others; and this especially, if they seem to themselves to have overcome all great vices, and are not yet arrived at a due sense of the many latent defects still remaining in them. And this is much increased by all opinions which represent the Supreme Being as implacable towards a part of his creatures, and this part as reprobate towards him. By all which we may see, that every thing which makes disagreeable impressions on our minds at the same time that our fellow creatures are present with us, in sensation or in idea, and especially if these be connected by the relation of cause and effect, &c. will in fact produce in us moroseness and peevishness. This follows from the doctrine of association, and is also an evident fact. It is likewise a strong argument for cheerfulness, and the pleasures of innocent moderate mirth.

87. Anger and revenge may be analysed as follows. The appearance, idea, approach, actual attack, &c. of any thing from which a child has received harm, must by the law of association raise in his mind the relict of that harm. The same harm often arises from different causes; and different harms from the same cause: these harms and causes have an affinity with each other: and thus they are variously mixed and blended together; so that a general confused idea of harm, with the uneasy state of the nervous system, and the consequent activity of the parts, are raised up in young children upon certain appearances and circumstances. By degrees the denials of gratifications, and many intellectual aggregates, with all the signs and tokens of them, raise up a like uneasiness by the law of association. And thus it happens, that when any harm has been received, any gratification denied, or other mental uneasiness occasioned, a long train of associated relicts of painful impressions enhance the displeasing feeling, and continue it much beyond its natural state. This is the nascent state of the passion of anger, in which it is nearly allied to fear, being in the continuance of the same internal feelings, quickened on the one hand by the actual painful or uneasy impression, but on the other moderated by the absence of the apprehension of future

danger. By degrees the child learns from observation and imitation, to use various muscular exertions, words, gestures, &c. in order to ward off or remove the causes of uneasiness or pain, and so goes on multiplying perpetually, by further and further associations, both the occasions of anger and the expressions of it; and in particular, associates the desire of hurting another, with the apprehension or actual receiving of harm from that other. As men grow up to adult age, and distinguish living creatures from things inanimate, rational and moral agents from irrational ones, they learn to refer effects to their more ultimate causes, and thus their resentment passes from the inanimate instrument to the living agent, especially if this latter be rational and moral. When the moral ideas of just and unjust, right and wrong, merit and demerit have been acquired, and applied to the actions and circumstances of human life, in the manner to be hereafter described, the internal feelings of this class have great influence in increasing or moderating our resentment.

88. Cruelty and malice are the genuine and necessary effects of anger indulged and gratified. They are most apt to rise in proud, selfish, and timorous persons, those who conceive highly of their own merits, and of the consequent injustice of all offences against them, and who have an exquisite feeling and apprehension in respect of private gratifications and uneasinesses. The low and unhappy condition of those around him, gives a dignity to a man's own; and the infliction of punishment, or mere suffering, strikes a terror, and so affords security and authority. Add to these the pleasures arising from gratifying the will, and perhaps some from mere curiosity, and from the rousing an obdurate callous mind to a state of sensibility. Thus we may perceive how nearly one ill passion is related to another; and that it is possible for men to arrive at last at some degree of pure cruelty and malice.

5. *Of the Pleasures and Pains of Theopathy.*

89. In order to form just ideas respecting the origin and nature of the theopathetic affections, it will be desirable to show what associations are formed with the word God, and with the equivalent and related terms and phrases.—Many of the actions and attributes of men are in common language applied to God; and it is probable that children in their first attempts to decypher the meaning of the word, suppose it to stand for a man whom they have not seen; and their visible conceptions connected with the term will therefore be that of a human form. When they hear or read that God resides in heaven, (that is, according to their conceptions, among the stars), that he made all things, that he sees, hears, knows, and can do all things, vivid ideas which surprise and agitate the mind are raised up in it; and if they have made some progress in intellect, they will feel great perplexity in their endeavours to realize such ideas to themselves; and this perplexity will add to the vividness of the ideas, and all together will transfer to the term God and its equivalent, such secondary ideas as may be referred to the heads of magnificence, astonishment, and reverence. When children hear that God has no visible shape, that he cannot be seen, &c. it adds much to their perplexity and astonishment, and at the same time destroys many of their former ideas: still however some visible ideas of the heavens, the throne of God, &c. seem to remain. When a child hears that God is the rewarder of good actions, and the punisher of evil actions, and that the most exquisite future happiness or misery (described under a great variety of particular emblems), are prepared by him for the good or bad respectively, he feels strong hopes or fears rise alternately in his mind, according to the judgment which he passes upon his own actions, founded partly upon the previous judgment of others, and partly upon an imperfect moral sense or conscience begun to be produced in his mind. At different periods of this progress, those ideas which have arisen from his filial relation, unite and blend with all the ideas previously connected with the term God, in consequence of the frequent application of the term Father to the Supreme Being; and there cannot be a reasonable doubt, that the notions and feelings which he has formed towards his earthly parents, at first form a considerable share in, and for a long period afterwards tend to modify those belonging to the term God.—On the whole, therefore, it is probable, that among Jews and Christians, children begin with a definite visible conception attached to the word; that this is by degrees obliterated without any thing of a stable precise nature succeeding in its room; and that by further degrees a great variety of strong mental affections recur in their turns when they think of God.

90. The affections exerted towards God,

may be classed under two general heads, love and fear: to the former may be referred gratitude, confidence, and resignation, also enthusiasm, which may be considered as a degeneration of it; to the latter, reverence (which is a mixture of love and fear), also superstition and atheism, which are degenerations of it.—The love of God, with its related affections, is generated by the contemplation of his bounty and benignity, as these appear from the view of the natural world, the declarations of the Scriptures, or a man's own observation and experience respecting the events of life. It is supported and much increased by the consciousness of upright intentions and sincere endeavours, with the consequent hope of future reward; and by prayer, vocal and mental, public and private, inasmuch as this gives a reality and force to all the ideas before spoken of. Frequent conversation and reading, in which the devout affections are excited, have great efficacy also from the infectious nature of our dispositions, and from the perpetual recurrency of the appropriate words, and of their secondary ideas, first in a faint state, afterwards in a stronger and stronger, perpetually. The contemplation of the rest of the divine attributes, His omnipotence, omniscience, eternity, omnipresence, &c. have also a tendency to support and augment the love of God, when this is so far advanced as to be superior to the fear; till then, these wonderful attributes enhance the fear so much, as for a time to check the rise and growth of the love. Even the fear itself greatly contributes to the generation and augmentation of the love, and in a manner greatly analogous to the production of other pleasures from pains. And indeed it seems, that notwithstanding the variety of the ideas and feelings which contribute to this affection, there is so great a resemblance among them, that they must languish by frequent recurrency, till ideas of an opposite nature, by intervening at certain seasons, give them fresh life.—On this theory, the love of God is evidently deduced in part from interested motives, directly, viz. from the hopes of a future reward; and partly from motives or sources of it, in which direct explicit self-interest does not appear, but which may be traced up to it ultimately. However, after all the sources of this affection have coalesced together, it becomes as disinterested as any other. It appears also that this pure disinterested love of God may, by a concurrence of a sufficient number of sufficiently strong associations, arise to such a height as to prevail over any other of the desires interested or disinterested.—Enthusiasm may be defined, a mistaken persuasion in any person that he is a peculiar favourite with God, and that he receives supernatural marks thereof. The vividness of the ideas of this class easily generates this false persuasion in persons of strong imaginations, religious ignorance, and narrow understandings, (especially where the moral sense is but imperfectly formed), by giving a reality and certainty to all the reveries of a man's own mind, and confirming the associations in a preternatural manner. It may also be easily contracted by contagion, as daily experience shows; and indeed more easily than most other dispositions, from the lively language used by enthusiasts, and from the great flattery and support which enthusiasm gives to pride and self-conceit.

91. The fear of God arises from a view of the evils of life, the threatenings of the Scriptures, the sense of guilt, the infinity of the divine attributes, and from prayer, meditation, conversation, and reading on such subjects. When confined in proper limits, it is awe, veneration, and reverence; when excessive, or not duly regarded, it degenerates either into superstition or atheism. Superstition may be defined, a mistaken opinion concerning the severity and punishments of God, magnifying them in respect of ourselves or others. Atheism is either speculative, which denies the existence of a God; or practical, which is the neglect of Him, where a person thinks of Him seldom, or with reluctance, and pays little or no regard to Him in actions, though he does not deny Him in words. Both kinds, in Christian countries, seem to proceed from an explicit or implicit sense of guilt, and consequent fear of Him, sufficient to generate an aversion to the thoughts of him, and to the methods by which the love might be generated, and yet too feeble to restrain from guilt: and it is the tendency of all pain to prevent the recurrency of the circumstances which produced it.

6. *Of the Pleasures and Pains of the Moral Sense.*

92. There are certain dispositions of mind with the actions flowing from them, which when a person believes himself to be possessed of, and reflects upon, a pleasing consciousness and self-approbation rises up in

his mind, exclusively of any direct explicit consideration of advantage likely to ensue to himself from his possession of those dispositions: in like manner the view of them in other persons raises up a disinterested love and esteem for those persons. And the opposite qualities and actions are attended with the condemnation both of ourselves and others. This is in general the state of the case; but there are many particular differences, according to the particular education, disposition, profession, sex, &c. of each person. The general agreement and particular differences in our ideas of right and wrong, and consequent approbation and disapprobation, seem to admit of an analysis and explanation from the following particulars.

93. First, children are for the most part instructed in the difference and opposition of virtue and vice, and have some general descriptions of the virtues and vices with which they are particularly concerned. They are told that the first are good, pleasant, noble, beautiful, fit, worthy of praise and reward, &c. the last odious, painful, shameful, worthy of blame, punishment, &c. So that the painful and displeasing associations previously annexed to those words in their minds, are, by means of that confidence which they place in their parents and instructors, transferred to the virtues and vices respectively. And the mutual intercourses of life have the same effect in a less degree with respect to adults and those children who receive little or no instruction from others directly. Virtue is in general approved and set off with all the encomiums and honourable appellations which any other thing admits of; and vice loaded with censure and reproaches of all kinds, in all good conversation and books. And this happens oftener than the contrary, even in bad ones. So that, as far as men are influenced in their judgments by those of others, the balance is on the whole on the side of virtue.

94. Secondly, there are many immediate good consequences which attend upon virtue, and many ill consequences upon vice, and this during the whole progress of our lives. Sensuality and intemperance, subject men to diseases and pain, to shame and anxiety; temperance is attended with ease of body, freedom of spirits, the capacity of being pleased with the objects of pleasure, the good opinion of others, the perfection of the senses and of the mental and corporeal faculties, &c. Anger, malice, and envy, bring returns of anger, malice, and envy from others, with injuries, reproaches, fears and perpetual disquietudes; and in like manner good will, generosity, compassion, are rewarded with suitable returns, with the pleasures of sociality and friendship, and with high encomiums. And when a person by the previous love of man is qualified to worship God in any measure as he ought, this affords the sincerest joy and comfort; while, on the contrary, the neglect of God, or practical atheism, murmuring against the course of providence, fool-hardy impiety, &c., are evidently attended with great anxiety, gloominess, and distraction, as long as any traces of morality or religion are left upon the mind. Now these pleasures and pains are often recurring in various combinations, and being variously transferred upon each other, from the great affinity between the several virtues and their rewards, and the vices and their punishments, will at least produce a general mixed pleasing consciousness, when we reflect upon our own virtuous affections or actions; a sense of guilt and anxiety, when we reflect upon the contrary; and also raise in us the love and esteem of virtue, and the hatred of vice in others.

95. Thirdly, the many benefits which we receive immediately from the piety, benevolence, or temperance of others, or which have some obvious connection with them, and the mischiefs resulting from their vices, lead us to love or hate the persons themselves by association, and then to love and hate the virtues and vices themselves, and this without regard to our own interest, and whether we view them in ourselves or others. The love and esteem of virtue in others is much increased by the pleasing consciousness which our own practice of it affords to the mind; and in like manner the pleasure of this consciousness is much increased by our love of virtue in others.

96. Fourthly, the great suitableness of all the virtues to each other, and to the virtue, order, and perfection of the world, impress a very lovely character upon virtue; the contrary self-contradiction, deformity, and mischievous tendency of vice render it odious, and the object of abhorrence to all who reflect on the subject. The terms which are employed to denote the pleasures of the imagination are employed in connection with virtue; and all the associated feelings attached to the terms are consequently associated with virtue, adding greatly, therefore, to the pleasures

derived from the contemplation of an act of sublime virtue.

97. Fifthly, the hopes and fears of a future life are themselves pleasures and pains of a high nature. When a sufficient foundation has been laid by a practical belief of religion, by thoughts of death, by the loss of friends, by corporeal pain, by worldly disappointments and afflictions, for the formation of strong associations of the pleasures of their hopes with duty, and the pains of these fears with sin, the repetition of these associations will at last make duty itself a pleasure, and convert sin into a pain, and give lustre and deformity to all their respective appellations. And these associations will gradually become so strong, that the express recollection of the hopes and fears of another world will vanish from the view of the mind.

98. Sixthly, all meditations upon God, and all the expressions of the feelings of our minds towards him, by degrees transfers all the perfection, greatness, and gloriousness of his natural attributes upon his moral ones, that is, upon moral rectitude. By these means we shall learn to be merciful, holy, and perfect, because God is so; and to love mercy, holiness, and perfection, wherever we see them.

99. Hence it appears that all the pleasures and pains of our nature, those of sensation, imagination, ambition, self-interest, sympathy, and theopathy, as far as they are consistent with each other, with the constitution of our minds, and with the course of the world, produce in us a moral sense, and lead to the love and approbation of virtue and to the fear and abhorrence of vice. This moral sense, therefore, carries its own authority with it, inasmuch as it is the sum total of all the rest, and the ultimate result from them. When it has advanced to considerable perfection, a person may be made to love and hate, merely because he ought; that is, the pleasures of moral beauty and rectitude, and the pains of moral deformity and unfitness, may be transferred and made to coalesce almost instantaneously.

IV. OF THE MOTIVE POWER.

100. In our general view of the primary mental faculties, we stated as an obvious fact, that 'without any external excitement of the nerves by which muscular motion is produced, the mind can produce such motion: in other words, that state of the motory nerves by which muscular motion is effected, can be produced by the mind.' To account for this fact, we infer that the mind possesses a power or capacity of influencing the motory nerves so as to produce muscular motion, which may be called the motive power.—Even supposing that the sensorial changes by which muscular motion is followed, whatever they may be, are of the same nature by external impressions; and admitting, what appears certain, that the associative power is the cause that ideas and sometimes that sensations produce motory changes of the sensorium, still we must infer the existence of a motive power, otherwise ideas and sensations could not be the exciting cause of muscular motion: in other words, whatever be the mental causes of muscular motion, that motion, if it begin from the mind, implies that the mind possesses the power of which we speak, separate from the cause of sensations, of ideas, and of the connections among them. Indeed it appears to be generally admitted, but is usually referred to the head of will.

101. A large class of the phenomena of muscular motion are explicable by the principle of association; and, as far as we perceive, they can be explained only by its laws. There are four classes of muscular motion; 1. Where it is produced by some foreign excitement of the muscular system, without the intervention of the mind, in which case it may be called involuntary; 2. Where it is produced by sensation without volition, or any other associated sensation, idea, or motion having been concerned in the connection between sensation and motion, in which case it is termed automatic in the Hartleyan nomenclature; 3. Where it follows that state of mind which we term will, directly, and without our perceiving the intervention of another idea, or of any sensation or motion, it may be termed voluntary in the highest sense of this word; 4. Where the motion has been voluntary, but is become automatic by the influence of the associative power, it is termed by Hartley, secondarily automatic. With the first of this class of motions, Mental Philosophy has little or nothing to do; as to the second, till more is known respecting the nature of those changes which take place in the sensorium, it can do little more than state the fact. The third and fourth afford farther illustrations of the doctrine of association, and we shall select from the Mental Principia such statements as will

suffice to explain the progress of muscular motion from automatic to voluntary, and from voluntary to secondarily automatic.

102. The most simple instance of this progress is in the action of grasping. The fingers of young children bend upon almost every impression which is made on the palm of the hand, thus performing the action of grasping in the original automatic manner. After a sufficient repetition of the motions which concur in this action; the sensorial changes preceding them are strongly associated with different ideas, the most common of which probably are, those excited by the sight of a favourite plaything or other object which the child is used to grasp and hold in his hand. He ought therefore, according to the doctrine of association, to perform and repeat the action of grasping, upon having such a play-thing, &c. presented to his sight: and it is a known fact that children do so. By pursuing the same method of reasoning we may see how, after a sufficient repetition of the proper associations, the sound of the words grasp, take hold, &c. the sight of the nurse's hand in a state of contraction, the conception of a hand in that state, and innumerable other associated circumstances, that is, sensations, ideas, and motions, will produce the action of grasping, till, in consequence of the action of grasping being found to answer certain purposes which are wished for, that state of mind which we may call the will to grasp is generated, and sufficiently associated with the action to produce it instantaneously. It is therefore perfectly voluntary in this case: and by the innumerable repetitions of it in this perfectly voluntary state, it comes, at last, to obtain a sufficient connection with so many sensorial changes, either sensitive, ideal, or motory, that (whether or not they are so vivid or so countenanced by the state of mind as to excite the consciousness,) it follows them in the same manner as originally automatic actions do the corresponding sensations, that is, to be secondarily automatic. And in the same manner may all the actions performed with the hands be explained, all those which are very familiar in life passing from the original automatic state through the several degrees of voluntariness, till they become perfectly voluntary, and then repassing through the same degrees in an inverted order, till they become secondarily automatic on many occasions, though still perfectly voluntary on some occasions, viz. whensoever an express act of the will is concerned.—A more interesting though more complicated case is that of the employment of the organs of speech, for which we refer our readers to Hartley's Observations, vol i. p. 106, or Priestley's Abridgement, p. 33.

103. We may hence understand in what manner the first rudiments are laid of that faculty of imitation which is so observable in young children. They see the actions of their own hands, they hear themselves pronounce. Hence the impressions made by themselves on their own eyes and ears become associated circumstances, and consequently must, in due time, excite to the repetition of the actions. Hence like impressions made on their eyes and ears by others, will have the same effect; or in other words, they will learn to imitate the actions which they see, and the sounds which they hear.—Imitation is a great source of the voluntary power, and makes all the several modes of walking, handling, and speaking, &c. conformable to those of the age and nation in which a person lives, and in particular to those of the persons with whom he converses. Besides the two sources of it just mentioned, it has many others. Some of these are the resemblance which children observe between their own bodies with all the functions of them, and those of others; the pleasures which they experience in and by means of all imitative motions; the directions and encouragements given to them on this head; the high opinions which they form of the power and happiness of adults; and their consequent desire to resemble them in these, and in all their associated circumstances. Imitation begins in the several kinds of voluntary actions about the same time, and increases not only by the sources alledged, but also by the mutual influence of every instance of it over every other, so that the velocity of its growth is greatly accelerated for some time. It is of the highest consequence to children in their attainment of accomplishments, bodily and mental. And thus every thing to which mankind have a natural tendency, is learned much sooner in society than the mere natural tendency would produce it; and many things are learned so early, and fixed so deeply, as to appear parts of our nature, though they may be mere derivatives and acquisitions.

OF THE SECONDARY POWERS OF THE MIND.

104. We did not set out with the hope of giving a complete outline of the most ex-

tensive subject of this article; but our readers will probably think us unnecessarily deficient if we say nothing respecting memory, conception, judgment, attention, abstraction, imagination, and will, which in books on the philosophy of the human mind constitute so important a part; and though we think the operation of the associative power of such extent, that separate from mere sensation and retention this ever-active principle will furnish a sufficient explanation of all the phenomena of intellect and affection, we agree with Mr. Stewart, that the common classification, having certainly some foundation in nature, should by no means be neglected. We shall accordingly, in the remainder of this article, and in those to which we shall now refer our readers, endeavour to give them such a view of the secondary faculties as may serve for the purposes which we originally proposed for ourselves. See UNDERSTANDING, or *Judgment*, in which, in connection with the article WORDS, we shall endeavour to lay before our readers a summary view of the highly important principles of Hartley, respecting those phenomena of the human mind which he classes under the head of understanding, or " that faculty by which we contemplate mere sensations and ideas, pursue truth, and assent to, or dissent from, propositions." The passions, affections, pleasures, and pains, are usually referred to the general head of will: respecting them we have already spoken at large. Of the other secondary powers of the mind, we shall here give a very short account, referring our readers to the " Elements of Dugald Stewart," (a work which we earnestly wish to see completed) for various sound and comprehensive views respecting them, mixed, we must confess, with several things in which we cannot agree, but which are so written as to delight even those whom they will not convince. We shall expect a most rapid progress of the Hartleyan philosophy, if the principles of it should ever be detailed in the imposing manner in which Mr. Stewart has given his to the public.

MEMORY.

105. The memory is defined by Hartley to be that faculty by which traces of sensations and ideas recur, or are recalled, in the same order and proportion, accurately or nearly, in which they were once actually presented.—The rudiments of memory are laid in the perpetual recurrency of the same impressions, or groups of impressions. These, by the operations of the retentive power, leave traces or relicts; and by the operation of the associative power, these are united in the order in which they were presented to the mind. Now, the single sensible impressions and small groups of them being few in comparison of all the large groups, they recur the most frequently, so as sooner to produce the elements of memory.

106. Suppose a person to have so far advanced in life as to have acquired all these elements; that is, that he has ideas of the common appearances and occurrences of life, under a considerable variety of subordinate circumstances, which readily recur to his mind by slight causes, he will be thus easily enabled to retrace other occurences; for these will consist either of the old impressions variously combined, or of new ones in some way or other connected with them. This may be exemplified and explained by the circumstance, that it is difficult to remember even well-known words which have no connection with each other; and still more so words which are neither familiar, nor formed according to familiar analogies; but that, on the other hand, persons acquainted with any branch of science or of art, very easily retain facts connected with it which were previously unknown.—The recollection of ideas is also greatly aided by the connection of words, both with them and with the original impressions; for words being, from the constant use of language, familiar to persons of moderate mental culture, even in various combinations, they are easily retained, and most materially assist in producing the recurrence of the corresponding ideas. And thus, when a person is relating a past fact, the ideas in some cases suggest the words, and in others, the words suggest the ideas. Hence illiterate persons, other things being equal, do not remember nearly so well as others. Hence also the importance, contrary to the views of education which a few years ago were so fashionable, of teaching the young to remember words as well as things; for in most cases, as words serve as the bond of ideas, ideas will be loose and floating in the mind, unless connected with words.

107. The difference between ideas and sensations principally consists in the greater vividness and distinctness of the latter; but cases are known to occur, in which visual conceptions are so vivid and distinct, that they are mistaken for actual sensations,

This is particularly the case when, in consequence of disease, the system is peculiarly susceptible of excitement; and sometimes when the mind is very much absorbed in contemplating its own ideas, so that the impressions from external objects produce little effect upon it. It is a fertile source of those ideas respecting apparitions which are so prevalent among persons of physical sensibility, without that culture of the intellect, which would enable them to attend to their own thoughts and manner of thinking. Such lively recollections of past impressions may, however, be usually distinguished from sensations, by allowing the attention to relax, so that they may cease to be forcibly detained as objects of consciousness; when it will, in general, be easily perceived that the mind loses sight of them, whereas it can lose sight of impressions from external objects only by fixing the attention upon ideas, or by corporeal motion of some kind or other.—These remarks might perhaps, with greater propriety, have been made under the head of imagination; because it is seldom that in such cases the vivid conceptions recur in the exact (or nearly exact) order of actual impression, which is the essential difference between the trains of imagination and those of memory: they are, however, referable to either class of phenomena.

109. Ideas of recollection differ from those of the imagination, principally in the readiness and strength of the associations; but partly, and in many cases almost entirely, by the connection of the former with known and allowed facts, by various methods of reasoning appropriate to the peculiar circumstances of the case, and by recollecting that we had before considered them as recollections, &c. Great difficulty, however, often exists, especially in the minds of persons with vigorous conceptions, who have not been habitually careful to cultivate accuracy of perceptions, and in the relation of recollections, to know whether the trains of ideas presented by the associative power are to be referred to the memory or to the imagination. Such persons seizing only the outline of a fact or series of occurrences, from habitual inattention to their sensations, are, from readiness of association, able to fill up the transcript, so as to make it appear plausible to themselves; and by once or twice detailing it without minute regard to accuracy except in those leading features, they give a vigour to the ideas and closeness to the association of them, which leads at last to the full conviction, that the whole is recollected. Cases of this sort are very frequent; and they often leave upon the minds of others, the belief, that such persons intentionally depart from truth, whereas sometimes the fact is, that part of their error arises from a desire to give the whole truth when they have only the materials for a portion of it in their minds. However the fault is one which should be carefully guarded against; particularly in the early part of life, by making young people of lively imaginations habitually attentive to the minute as well as the leading parts of their impressions.—All persons are at one time or other at a loss to know whether trains of vivid ideas, succeeding each other readily and rapidly, are ideas of recollection or of imagination, that is mere reveries: and the more they agitate the matter in their minds, the more does the reverie appear like a recollection. Persons of irritable nervous systems are more subject to such fallacies than others; and insane persons often impose upon themselves in this way, viz. by the vividness of their ideas and associations, produced by bodily causes. The same things often happens in dreams.

110. The vividness and readiness of recollected trains, is also one grand means of ascertaining the dates of facts; for as this diminishes, (other things being equal), in proportion to the period which has elapsed since the reception of the ideas, and the formation of the associations, if the vigour of these be diminished, we refer them to a more remote period in proportion to that diminution; and if by any cause it be kept up, the distance of time appears diminished. Thus it is, that if any interesting event, the death of a friend, for instance, have been often recollected and related, till we come to make oral or mental calculations, it appears to have happened but yesterday, as we term it. However, from this circumstance we are often apt to confound events, as to the order of time, referring them to more recent or remote periods, according to the strength and vigour of the ideas and associations, or the contrary. In general we judge of the period of events by associated circumstances, particularly by visible permanent memorials. And hence it happens that illiterate persons have often great difficulty in assigning periods to events with any tolerable accuracy. Our readers, when they take such things into account, and consider how difficult it must in most

cases be for illiterate persons who have frequently changed their employments, to refer such changes to any specific dates, will not feel unwilling to admit, that the presumption formed against the reputed murderers of Steele, in consequence of their incorrect statements as to their places of employment four years before their trial, should have weighed very little in the decision against those unhappy men.

111. We distinguish a new place, person, &c. from one which we remember in a manner similar to that in which we distinguish between recollected ideas and those of imagination; by the greater vividness of the impression, and the strength and readiness of the associated circumstances. If we doubt whether we have before seen a person who is newly introduced to us, we try to recal some associated circumstance, such as the time and place where we may be supposed to have seen him; and if this prove erroneous, we immediately infer that our doubt arises from some resemblance which he has with some one whom we then or there saw, or with some one whose face is familiar to us.

112. The memory of children is imperfect, because the elementary rudiments of memory are not sufficiently fixed by the retentive power, nor their usual groups sufficiently formed in the mind. They are also imperfect in the use of those words and other symbols which so materially aid the recollection; and in particular they are found very deficient in arranging facts in the order of time, judging most frequently from the vividness of their recollections, and not having the use of those denotements of time, on which the memory principally depends for accuracy in this branch of recollection. In old persons, whatever be the part of the system on which the retentive power depends, that power is most materially diminished, as also the sensitive power, while the associative power has, in their habitual direction of it, been strengthened in its operations. Hence new impressions can scarcely be received, and seldom are retained; while the parts which are received and retained excite old trains of associations rather than continue those which were recently impressed. When old persons relate the incidents of their youth with great precision, it is rather owing to the recollection of many preceding recollections and relations, than to the recollection of the thing itself.

113. Memory depends greatly upon the state of the brain. Concussions, and other disorders of the brain, and the use of spirituous liquors, impair it: and it is recovered by degrees as the causes which affected the brain are removed. In like manner dreams, which happen in a peculiar state of the brain, viz. during sleep, vanish as soon as vigilance, a different state, takes place; but if they be recollected immediately upon waking, and thus connected with a state of vigilance, they may be remembered.

114. When a person desires to recollect a thing that has escaped him, suppose the name of a visible object, he recals the visible idea, or some other associate, again and again by a voluntary power, and thus at last brings in the required association and idea. But if the desire be very great, it changes the state of the brain, and has an opposite effect, so that the desired idea does not recur till all has subsided, perhaps not even then.

115. The excellence of memory consists partly in its strength and accuracy of retention, partly in the readiness of recollection. The former principally depends on the strength and accuracy of perception in attention to our sensations, and partly upon the associative faculty; the latter depends entirely upon the strength and peculiar biases of the operations of that power. The intellectual faculties depend greatly upon the memory: hence though some persons may have strong memories with weak judgments, yet no man can have a strong judgment with a weak original power of retaining and remembering.—Before we conclude our view of this faculty, we beg leave strongly to recommend to our younger readers, especially if they possess a philosophic cast of mind, an attentive perusal of the very useful and interesting chapter of Dugald Stewart on this subject, particularly those parts which relate to the improvement of the memory.

CONCEPTION.

116. We have mentioned this as one of the secondary faculties of the mind, because it is considered as a distinct faculty by Mr. Stewart, whose authority we in many cases respect; and who we suppose has in this instance produced, in many of his admirers, a belief in the justness of his statements, which we think far from well founded. We shall have an opportunity of stating our opinion respecting it under the next head,

and shall therefore decline enlarging upon it here.

ATTENTION, ABSTRACTION, AND GENERALIZATION.

117. By investigating the phenomena of mind at a time when we have formed a connection between volition and certain mental states or operations, we are repeatedly led to consider those states or operations, however passive the mind might originally have been, as totally, and in their own nature voluntary.—This is remarkably the case with that state of mind which we call attention. That this is in young children intirely involuntary, is apparently certain, and those who are endeavouring to form their minds to habits of study and reflection, know from constant experience that they have it not under their command. So far from having an original power of excluding vivid ideas or sensations, to give our attention to those which, though most certainly demanding it, do not make the same lively impression upon the mind, it is a habit which requires the strictest and severest discipline to produce it; it is a possession honourable and invaluable, but like every other of importance, not the acquisition of the moment, but of a long continued course of rigorous, and in many cases, of painful exertion. And when the habit of attention is formed, that is, when we can produce the state of mind called attention by a volition, how much may fairly be attributed to the nature of the object, which though, perhaps, at first uninteresting, becomes pleasing and impressive, and thus produces that state by the original laws of our constitution.—It even appears probable that the person who has formed such habits of attention to a particular science as to be able to give it his undivided attention, would be almost as incapable of directing it to frivolous objects, as to a science to which habitual attention, or the nature of the subject, does not give any charms, as he was when he first entered upon his pursuits.—In a word, when we take into consideration the circumstances that our attention is never undivided, except to those things which are calculated to engage it, either by the original agreeableness of their nature, or that which they acquire in proportion as our habits become confirmed, and that the associative faculty may, and in many instances does, form a connection between the mental states we call attention and volition; we have probably then sufficient data to account for the phenomena of attention without calling in the aid of a new faculty.

118. Abstraction is defined by Mr. Stewart, the faculty by which the mind separates the combinations which are presented to it. This definition, so far as it goes, appears to be very correct; but if the processes of generalization are intended to be contained in it, it is by no means sufficient; as will immediately appear from the slightest consideration of that mental process. Abstraction, in this acceptation, is indeed "essentially subservient to every act of classification;" but by no means comprehends that act in the number of its functions. Though we cannot agree with Mr. Stewart in all his statements in his chapter on attention, we must in this position, that the mind "cannot attend at one and the same instant to objects which we can attend to separately." If this be the case, what is abstraction but attention directed to particular objects, owing either to something vivid in the sensations they excite, or to the frequency of their recurrence; in fact, subject to all the laws of attention, perfectly involuntary in early life, and afterwards becoming, to a certain degree, voluntary by means of a strong association formed between the states of mind called volition and attention.

119. In speaking of the process of generalization, some observations will apply to the process of abstraction separately considered. We shall therefore proceed to consider the formation of general or abstract notions; a process in which the mind is most usually passive; which seems capable of satisfactory explanation upon the principle of the associative powers, and apparently cannot be explained without it.

120. Sensible objects, and particularly visible, are undoubtedly the first which exercise the power of abstraction, or separate attention, and here the process appears plain. The object makes its appropriate impression upon the organs of sense, and when withdrawn leaves in the mind an idea. Another sensation is received from an object bearing strong features of similarity to the former, by the laws of association, it calls up the idea it produced, and becomes associated with it. Other similar objects are presented, and the features in which they agree being the most frequently called up, engage most the attention of the

mind, and thus becoming, in some degree, separate from the objects which originally were connected with them, constitute the abstract idea. The readiness with which these circumstances of resemblance, recal the idea or conception of the individuals from which they were abstracted, depends upon the habits of the individual, and the number of objects from which the abstract notion was formed. If we had seen but two or three sheep, it is probable that the circumstances of resemblance would be so connected in our minds with the individuals, that one or more of them would be constantly called up when considering the circumstances of resemblance; but if the number be much greater, that is, if the circumstances of resemblance have been frequently in the mind, particular individuals much less frequently, the notion of these circumstances of resemblance becomes somewhat disjointed from the objects by which it was formed. And though it is probably impossible to have a general idea of any class of objects merely sensible, without the idea of an individual being present in the mind; yet from the causes I have mentioned, the general features of resemblance not being particularly connected with any individual, those features only are strong and vivid, and call the attention of the mind, while all the other circumstances of dissimilarity have no effect upon it, and do not attract its attention.

121. The procedure of the mind appears to be exactly the same, though less obvious, and usually more difficult of analysis, when the general idea is more remote from sensation, when, in fact, the notions of the quality, or qualities, even in the individual, may be very complex, and this in proportion, as it is more intellectual and refined. —In the former class of general notions, and even in some instances of the present, where the quality is definite and obvious, it is probable that language would not be requisite for the formation of ideas; indeed, if the above account be just, it cannot be requisite. For the abstraction, so far as it is involuntary, is solely the effect of the frequent recurrence of some particular qualities with which they are occasionally combined. But those abstract ideas in which the circumstances of resemblance between the composing ideas, are not very obvious or very distinct, either would not have been formed at all by the bulk of mankind, or at least would have been very confused.—We can go very far with those who contend that general ideas would not exist in the mind without the medium of language; but that they could not, from any deficiency of mental capacity to form them, does by no means appear certain. The same faculties which now produce them, might have produced them without the powers of communication; and there appears no reason why the deaf and dumb child may not form a general idea of men, or horses, or fire, or any object of a similar kind, as well as if capable of annexing terms to the objects of perception.

122. It can be no objection to this account of the procedure of the mind in generalization, that we are able to form classifications of objects from circumstances which are not calculated to strike the mind of the common observer. When left to itself before habits of reflection are formed, the mind will be necessarily attracted by the most prominent sensible features of resemblance, and the objects would become associated by that bond of union; and in very many cases this would differ in different individuals; but it is indubitable that we may acquire such a command over our associations, that we may be able to combine objects in our minds which have no customary tendency to such combination, owing to the laws of association, by a more factitious connection, and that by the requisite culture of the mind, certain connecting principles are either discovered or confirmed, which could not have been of any force in a more early period of mental progress. In the first of these cases the association is voluntary, and if there were not some apparent benefit resulting from it, or some circumstances calculated to produce it in the mind, it would soon give place to a more natural union. So far, however, as any general idea is formed, its production is accomplished agreeably to the principles we have stated. In the second the operation of the mind is most usually involuntary; when voluntary, the observations on the first cease to apply.

123. It is obvious that the fewer and more distinct the circumstances which are comprehended under the general notion of a class of objects, the more clear and definite will be the general notion itself. And it appears worthy of notice, and tends to confirm the account given of the formation of our general ideas, at least those of visible objects, that the greater the variety subsisting among the individuals or subordinate species comprehended under the

general idea, or, more properly, which possess that quality, or combination of qualities, which compose the general idea, the less attention, other things being equal, do we pay to the peculiarities of the individual. Thus the general notion of a triangle is merely that of a figure having three sides; and the varieties of triangles are innumerable: and, agreeably to the opinion already mentioned, though we certainly cannot form a conception of a triangle which shall be representative of all others, without possessing the peculiarities which constitute it an individual, yet the circumstances of its having three sides is so finite, and our attention is so thoroughly confined to it, that the peculiarities of the triangle are not unfrequently totally out of consideration; and if, owing to some particular associations, the triangle on such occasions were not usually the same, we should afterwards be unable to say what kind of a triangle had been in the view of our minds.

124. To state the fact respecting conceptions more generally; if we attempt to form a conception of any object, it must, from the very nature of a conception, be individual, representative, perhaps, of a numerous class, but still possessing those peculiar features which constitute individuality. —It may not be improper to suggest, that the want of attention to the difference between an idea and conception may have, in some measure, misled those philosophers who have denied the existence of general ideas. "The business of conception," says Mr. Stewart, "is to present us with an exact transcript of what we have felt or perceived;" and, admitting the truth of this, a conception is that transcript so presented. —We shall not enter into the enquiry, whether conception be a distinct faculty of the mind: we may, however, state, that it appears to us to be nothing different from memory, except as being a branch of that general faculty; and that a conception differs from an idea, only as species does from genus; that, in fact, without the aid of the associative faculty, and with retention alone, every idea would be merely a conception. For the recollection of an individual sensation, or group of sensations, whether seldom or frequently received, is a conception; but when a number of sensations possessing some common features, but in others differing, are received into the mind, the ideas they form there by the laws of association, coalesce with one another, thus constituting these complex ideas or states of mind, which never from their very nature can be conceptions, but which yet may be distinct, and when words are used to denote them, the subjects of reasoning.

125. To apply these remarks. Almost an infinite variety of the sensations we receive, are presented to our view so constantly connected with others, that however much it may be in the power of the mind to attend to them in a separate state, it is impossible to form a conception of them separately; but, on the other hand, there are a considerable number of qualities remote from mere sensation, belonging to an extensive range of individual objects, which may be considered by the mind separate from those objects, and have internal feelings or complex ideas attached to the terms which denote them. Now, we apprehend, it is the grand difference between our general notions, when concerned about things merely sensible, and those which we might call more purely intellectual, that in the former case, the conceptions being usually clear, and frequently very vivid, are very easily brought up by the associative power; and the circumstances of distinction being few, and merely sensible, are, from their very nature, calculated to produce a conception; and so little do we possess an abstractive power, that it is in most cases impossible to do this without introducing the conception of the whole object: on the other hand, the circumstances of distinction in the latter case, are less definite; they are frequently extremely numerous, and are seldom capable of exciting conceptions, and consequently they do not readily call up any particular individual object to which the general term is applicable.— We acknowledge, very much, in these latter respects, depends upon the peculiar circumstances of the case, or upon the habits of the individual. If a person had been remarkably struck with an act of justice, or of disinterested benevolence, or any other, it is probable, that while the vividness of the impression lasted, he would never be able to think of these qualities without the particular case being recalled into the mind; and if he possessed a lively imagination, or had been present at the performance of the virtuous action, would form an immediate conception of the whole scene. Or if a person be not much in habits of speculation, he would universally think of some example of the action possessing those qualities.—But these circumstances, though they tend to illustrate the operation of the

associative power, do not appear to militate against the general truth of the above remarks.

126. The remarks we have made on the subject of abstraction or generalization, have been, in a considerable degree, separate from language, or at least supposing it not already formed. If every person was left to form his own classifications, language, in very many instances, would be of little utility; because the same features of resemblance would not operate in the same way upon different individuals. But the process of the mind, when language is formed, is somewhat different; because in this case it is restrained, and has not the same unbounded liberty of forming its associations. —The mind of the child is not left to classify objects; but these objects are presented to it already classed, owing to the same word being used to express them; and it is very interesting to observe the efforts of the juvenile mind in finding out some features of resemblance between the objects which had previously been presented to him, and a new object presented to him with the same name.

IMAGINATION OR FANCY.

127. In the use which Mr. Stewart makes of the term imagination, it includes the fancy, and is in no respect a distinct power, as he himself states, but compounded of several others. "It includes," he says, "conception or simple apprehension, which enables us to form a notion of those former objects of perception or of knowledge, out of which we are to make a selection; abstraction, which separates the selected materials from the qualities and circumstances which are connected with them in nature; and judgment or taste, which selects the materials and directs their combination. To these powers we may add that peculiar habit of association to which I formerly gave the name of fancy; as it is this which presents to our choice all the different materials which are subservient to the efforts of imagination." "This," he observes in another place, "is the proper sense of the word, if imagination be the power which gives birth to the productions of the poet and the painter," and, we may add, of genius in general.—We have no objection to such an appropriation of the term; in the Hartleyan nomenclature, however, it is used indiscriminately in the sense in which the professor seems to employ the fancy.

128. The recurrence of ideas, says Hartley, especially visible and audible ones, in a vivid manner, but without any regard to the order observed in past facts, is ascribed to the power of imagination or fancy. Every succeeding thought is the result either of some new impression, or of an association with the preceding. It is impossible, indeed, to attend so minutely to the succession of our ideas, as to distinguish and remember for a sufficient time the very impression or association which gave rise to each thought or conception; but we can do this as far as it can be expected to be done, and in so great a variety of instances, that we have full right to infer it in all.—A reverie differs from imagination only in this, that the person being more attentive to his own thoughts, and less disturbed by external objects, more of his trains of ideas are deducible from association, and fewer from new impressions.—It is to observed, however, that in all cases of imagination and reverie, the train and complexion of the thoughts depend, in part, upon the then state of body or mind. A pleasurable or painful state of the stomach, for instance, joy or grief, will make all the thoughts tend to the same cast. "Objects and circumstances may be so disposed," says Mr. Grant, (in a very valuable paper on Reverie, for which see "Manchester Memoirs," vol. i. or "Nicholson's Journal," vol. xv.) "as to give to reverie a pleasing or pensive, a refined or an elegant direction. I believe it is unnecessary to ask whether the mind will not be more apt to depart from serious meditation in a gaudy chapel, than in the solemn gloom of a cathedral? It is remarked by an eminent medical writer, that light, introduced by opening the window-shutters, gave a gayer cast to the ideas of a patient who laboured under reverie. The study of Tasso was a Gothic apartment, and he fancied his familiar spirit to converse with him through a window of stained glass."

129. We might very easily enlarge on this faculty, and particularly on the regulation of it, as affecting the character and the happiness; but we suppose that none of our readers, who are much interested in the pursuits of mental philosophy, are without access to Dugald Stewart's "Elements," in the last chapter of which they will find an elegant, scientific, and highly important consideration of this point; and as we have already gone to the limits of our article, we must hasten to a conclusion.—Our object

has been to lay before our readers a view of the leading features of the most important of all sciences next to religion, to which it is eminently subservient; and in accomplishing this object we have endeavoured to show its practical value. We have, in many places, made a most free use of Hartley's "Observations;" and we shall think ourselves happy if we shall have succeeded in making the way smoother for an acquaintance with that profound and invaluable work, among such of our readers as have not previously paid much attention to the subject. To such we beg leave to recommend Mr. Belsham's "Elements," (of which we believe we have occasionally made use, without specific acknowledgment), Locke's "Essay," Dr. Priestley's "Abridgment" of Hartley, Allison's "Essays on Taste," and Professor Stewart's "Elements," as forming a pretty complete course of reading on Mental Philosophy.

130. As we have made a reference from METAPYHSICS to this article, our readers will probably expect from us something more metaphysical than what they will find in the foregoing part of it. We are not among those who consider metaphysics as that science, falsely so called, which professes to enlarge human knowledge beyond the limits of the objects of human contemplation, as the science of essences, &c.; but we must acknowledge that we are disposed to allow a high rank to a few only of those branches of metaphysics which do not justly class under the head of mental philosophy, or the philosophy of the human mind. We regard them as amusing speculations which may serve to sharpen the activity of the intellect, and which, confined within moderate limits, may be safely indulged in by those whose time and culture of intellect allow of such indulgence; but we are no advocates for the young philosopher spending his exertions upon them: they may, and we are aware often do, deeply interest the mind; but few who think much will be unwilling to allow that an active imagination, or simply the devotement of the mind to an object, will create any interest in that object which has no foundation in the real utility of it. We make these remarks with no wish to throw a stigma upon metaphysics in general, but simply to lead our readers to reject that stigma which many throw upon the philosophy of the human mind, but which belongs to some only of the branches of metaphysics; and of these, principally to those which the good sense of the present day regards merely as objects of curiosity, notwithstanding the efforts of the learned Harris to lead us back again into all the vagaries of the ancient philosophers. Whatever relates to the properties of the mind, to the operations of intellect and affection, is of high value in various points of view: as Dugald Stewart justly remarks, the philosophy of the mind, abstracted entirely from that eminence which belongs to it in consequence of its practical applications, may claim a distinguished rank among those preparatory disciplines, which Bishop Berkeley has happily compared to "the crops which are raised, not for the sake of the harvest, but to be ploughed in as a dressing to the land."

131. Physics, including in its widest extent natural history, is that grand division of human knowledge which has for its objects the properties, classifications, and laws, of all those things which affect the senses; metaphysics, μετα τα φυσικα, comprehends all those speculations which have for their aim the properties, classification, and laws, of all those objects of human thought which by sensation alone could not be known to man. The ancient metaphysics comprehended many objects which can scarcely be said to lie within the sphere of human knowledge, and which are rather to be considered as the reveries of imagination than as the realities of intellect; with these the science of metaphysics ought not to be confounded. We cannot pretend to give a complete enumeration of the objects of this science, but it will not probably be useless to give such a statement and brief consideration of them, as will at least more fully explain than is perhaps generally done, what kind of knowledge it professes to have in view.

132. In the first place, metaphysics comprehends all investigations respecting the existence and attributes of the Supreme Being. While we state this, however, we admit that we use the term in its widest extent. The most important, because the most undeniable, and generally convincing of these investigations come under the head of natural theology, which derives its proofs of the existence and attributes of the Supreme Being from the appearances of nature. Revealed religion teaches us what God himself has been pleased to make known to us of his character: but this, though a just foundation of belief on this point, and the guide of sound philosophy,

scarcely comes under the head of philosophy. Those religious investigations which most properly class under the head of metaphysics, tend to prove the Divine existence and attributes from certain principles which are supposed to be indisputable, by a series of reasoning altogether independent of the marks of design in the objects around us. Of these, we think that those which are to be found at the beginning of the second volume of "Hartley's Observations," are the most satisfactory. He sets out with this principle, 'something must have existed from all eternity,' which he thinks commands an instantaneous necessary assent, or at least the contrary of which (*viz.* that there was a time when nothing existed) the mind of every one refuses to admit. He next proceeds to show, that 'there cannot have been a mere succession of finite dependent beings from all eternity; but there must exist at least one infinite independent being.' He concludes his reasoning in proof of this proposition, with a remark which we will quote, because many, feeling themselves embarrassed with what may justly be called the metaphysical proof of the existence of God, are apt to suppose, either that it has no weight, or that there is in their minds some wrong tendency, mental or moral, which impedes a ready assent to it. "Some of these (abstract metaphysical arguments) are more satisfactory to one person, some to another; but in all there is something of perplexity and doubt concerning the exact propriety of expression, and method of reasoning, and perhaps ever will be; since the subject is infinite, and we finite." Indeed, we are decidedly of opinion, that any mind would justly be deemed an anomaly which, after resisting assent to the proof, *à posteriori*, fairly and attentively weighed and understood, should be led by the proof, *à priori*, to admit the existence of a first cause: and we strongly incline to the belief that the conviction which may be supposed to be derived from the latter, is in reality founded upon a previous, perhaps casual and even unintentional, consideration of the former.

133. This remark still more forcibly applies to the *à priori* arguments for the attributes of God. It is supposed to follow from the necessity of the existence of an infinite, independent being, that he necessarily is endued with infinite power and knowledge. We admit that it by no means follows, from what we think an indisputable position, *viz.* that no human intellect could have inferred the one from the other without the *à posteriori* proof, that therefore this inference has no force; but we do think that it is on the works of God alone that we can found a full and satisfactory proof of his power and knowledge; when these are admitted, however, we must resort to a metaphysical, but simple argument, to prove that they are unlimited. — We do not wish to lead our readers to the idea, that Hartley confines his reasonings to the *à priori* argument for the attributes of God; for this is by no means the fact; and we beg leave strongly to recommend to those of our readers who have not previously attended to them, those parts of his works which relate to the Supreme Being; we consider them as a treasure of profound reflections, which will serve as a clue to numberless difficulties, which may have perplexed and distressed the mind on the respective subjects.

134. Many proceed further in the metaphysical arguments respecting the attributes of God, and endeavour to prove, that the infinite, independent Being, possessed of infinite power and knowledge, must be infinitely benevolent. We acknowledge ourselves able to feel no other ultimate proof of this position than (what abundantly proves the benevolence of God, though perhaps not immediately the infinite benevolence) the happiness and tendencies to happiness which are observable in the sentient beings which fall under our notice. Admit the benevolence of God from his works, and then the infinity of that benevolence may be shewn by a simple metaphysical argument. "Since the qualities of benevolence and malevolence are as opposite to one another as light to darkness, they cannot coexist in the same simple, unchangeable being. If therefore we can prove God to be benevolent, from the balance of happiness, malevolence must be entirely excluded; and we must suppose the evils which we see and feel to be owing to some other cause, however unable we may be to assign this cause, or to form any conceptions of it."—The divine benevolence, in every just view which the human mind can take of it, includes every moral quality which can exist in the divine mind; holiness, justice, mercy, truth, all, as attributes of God, are only modifications of benevolence: we need not therefore pursue these considerations further on this point.—Connected with the divine benevolence is one important class of speculations, *viz.* those which refer

to the existence of evil. This is a subject which has for ages exercised the human understanding, and still it is regarded as the chief difficulty with which the theist has to contend. We will not attempt to weaken the reasonings of Hartley on this point, by laying an outline of them before our readers; but we confidently refer to his observations, as containing the most solid and satisfactory investigations respecting it, and what to all who fully admit his principles of mental philosophy must give views which shew the value of those principles which, from their consistence with the dictates of religion, both derive confirmation and lustre.

135. Besides these objects of metaphysical speculation in connection with the Divine Being, there are some which seem to us to rank with the ancient metaphysics; such as, the mode of the divine omnipresence, the nature of the divine infinity, &c. Such things, it may reasonably be supposed, cannot be comprehended by finite beings; and if so, they cannot be the objects of human science, nor consequently of the pursuit of a wise man; but this no more argues against the science of metaphysics, than the absurdity of the pursuit of a perpetual motion against the science of mechanics, or of the search after the philosopher's stone against the study of chemistry.

136. Secondly, in the extensive sense of the term metaphysics, it comprehends all investigations respecting the operations, powers, and laws of the human mind (which class under mental philosophy,) and respecting the grounds of obligation and of human duty, as far as they are derived from the consideration of the mental frame, (which class under moral philosophy.) It appears, however, that the term is more closely appropriate to those investigations which have for their object subjects connected with the study of the human mind, but which concern rather abstract speculation than practice; for instance, whether the human mind is a distinct, independent substance, or whether the human frame consists of one uniform substance and perception, with its modes, is the result, necessary or otherwise, of the organization of the brain; whether the human mind is necessarily incorruptible and immortal; whether there is an external world as the cause of our sensations; in what personal identity consists; whether power is an attribute of the human mind, &c.

137. Respecting the homogeneity of the human frame, we have already had an opportunity of saying a few words near the beginning of this article: it appears to us a purely metaphysical question, almost solely of importance in consequence of the frequent misrepresentations (real, though probably unintentional) of the opinions of those who hold the affirmative side of the question, and of its supposed connection with the natural immortality of the soul. The fact is, that the modern materialists may be considered as having proved, what is admitted by some of the ablest natural philosophers, that solidity, and the absence of all active power, are not properties of matter; and while the principle of vitality is on all hands admitted as the result, necessary or otherwise, of a certain structure of matter, they see no greater difficulty in the hypothesis that the principle of percipiency is also. Perhaps, if the question had been taken up respecting the lowest of the animal tribes, all of which possess percipiency, and it had first of all been considered whether the phenomena of percipiency in them required the admission of a substance different from that by whose organization the phenomena of vitality in them is produced; and next, whether there is any essential difference between the percipiency of the lowest animals, and those which form the gradual ascending links between them and the highest of the brute creation; and, lastly, whether there is any essential difference between the phenomena of percipiency observable in them and those in the uncultivated and almost brutal savage; if, above all, all ideas of connection between the immateriality of the human soul and its natural immortality had been relinquished, the question would have appeared less formidable, and admitted of an easier decision.

138. The affirmative of the next question, respecting the natural immortality of the soul, appears to us to be totally beyond the power of man to prove, from the light of philosophy at least. We have no idea of a substance separate from its properties; and even admitting that the human soul is a distinct substance from the body, what property is it known to possess which necessarily implies indestructibility? What proof is there that sensation, memory, intellect, or affection, must necessarily continue, when the substance with which they are at least united, ceases to exist in its organized state? We do not say, that the contrary can be proved; but we are not metaphysicians enough to discover any arguments for the once common hypothesis, (now, we believe, usually relinquished by philosophical

immaterialists), which have not been already found inadequate to prove the point. The question seems indeed of very little consequence, except to those who quit the guidance of revelation; all must depend on the will of the Supreme Being; and the indications of his will to be derived from the moral arguments for a future life, and still more from the Christian revelation, are worth a host of reasonings to prove, that a substance of which we can know nothing, excepting its property of percipiency, possesses what cannot follow from percipiency, because we have satisfactory ground to believe, that percipiency is at times totally suspended.

139. We shall have an opportunity of offering a few remarks on the next of the metaphysical enquiries which we have mentioned, in the article TOUCH, or FEELING, *sense of;* and we therefore proceed to the following subject, *viz.* respecting personal identity. This is a point of considerable importance, since, if the circumstances which constitute personal identity could be shown to be inconsistent with the infinitely important doctrine of a future life, it would greatly affect the evidences for that doctrine; but the fact appears to be, that all which true philosophy has to do, is to bring back the airy speculations of some metaphysicians to the level of common sense; to show either that they are unfounded, or that they have no immediate tendency to affect the belief in a future retribution.—That we are through life, and under every change of body and of mind, the same intelligent accountable beings, is a fact which we know by consciousness; and whether we will or not, we must accept of this evidence. The only question is, what are the circumstances which constitute identity of person, amidst all the changes of body and of mind which a man undergoes in the course of a long life? If any and every hypothesis for the solution of this problem be insufficient, it does not follow that there is no such thing as personal identity; but merely that such hypothesis is unsatisfactory and untrue. The fact is, that different hypotheses have been advanced on the subject, that perhaps no one of them can be pronounced fully satisfactory, and that some metaphysicians, laying hold of the weak parts of such hypotheses, have actually professed to believe, that there is no such thing as personal identity. The conviction, however, of permanent identity is happily too firmly inwrought in the mental system, to allow any thing but an attachment to system little short of insanity to eradicate it. Whether or not we can ascertain in what it consists, the consciousness of every individual is a constant and sufficient ground for his admitting the fact; and if any one should work up his mind to a speculative disbelief of it, while he continues to possess a prospective and retrospective capacity, sensation and mental feeling, he cannot, in any considerable degree, as far as this life is concerned, act upon his opinion. The chief importance of such an error respects its connection with a future state of retribution; and even here the incredulity of vice alone can, we should suppose, produce in a sane mind any doubt as to the continuance of identity. The grand point is, will the system of thought and affection to which the word *self* is applied, be raised again to activity; and if so, (and no contradiction can be urged against the strong evidence which we have for it), all is safe as far as respects the sameness of that self. And if to constitute personal identity it should be necessary that more than the same organization of matter be preserved as a vehicle for that system of thought and affection, that even the same system of particles should be preserved. Dr. Watts's hypothesis of permanent stamina, which, if not actually proved, has never been disproved, affords a proof of personal identity in this sense of the word, which may satisfy the most scrupulous materialist, and the most captious sceptic.—Respecting this subject, we refer our readers to the work from which we have derived several of the foregoing statements, *viz.* "Belsham's Elements of the Philosophy of the Human Mind;" where they will find a luminous view of this difficult subject, and references to the chief writers who have discussed it. They will also find in the same useful work, a view of several other of those discussions which we consider as most strictly metaphysical, with similar references.

140. The last of those questions which we spoke of in this department of metaphysics, is, whether power is an attribute of the human mind. "Power, as an attribute of the mind," says Mr. Belsham, "may be defined, the capacity of carrying into effect the determinations of the will." Those philosophers who maintain, that it is an attribute of the human mind, argue from consciousness and observation; and they affirm, that though we cannot define it, we have a notion of it. Those who take the

negative side of the question, contend, that all we are conscious of, is volition, and the effect produced; and that what some call a consciousness of power, is nothing more than a belief, that the effect will follow the volition, which belief is sometimes erroneous: they also argue, that our total ignorance of the manner in which muscular motion is produced, proves that the mind is not the efficient and proper cause of this wonderful effect.—We are of opinion, that it is very much, though not wholly, a dispute about terms. Upon Mr. Belsham's definition of power, we should have supposed, that no difference of opinion could exist, whether it be a property of the mind; but they are very different questions, whether the mind possess such capacity in consequence of the ordinations of the Supreme Being, and whether, when exercising this capacity, it is to be considered as the efficient cause of muscular motions. In this sense, all causation appears to resolve itself into the constant agency of the Deity; and we see no reason to hesitate in admitting, that all the energies or powers both of body or of mind, are simply modes of his operation.

141. Some of our readers will probably be disposed to censure us, because we have not ranked the doctrine of necessity, as it is called, among the metaphysical speculations of this class. We are fully aware, that there is an abundance of abstruse discussion connected with it; but in its unincumbered, simple state, the doctrine of motives seems to rank among the practical laws of our frame. At any rate, we shall not here enter upon the subject, having already given a short statement of the subject in its proper place: to which, therefore, we beg leave to refer our readers.

142. Thirdly, metaphysics claims as its own, all enquiries respecting the nature of infinity, motion, duration, space, &c. We do not mean to affirm, that these inquiries are destitute of value, certainly not that they are destitute of interest; but we cannot, as far as they are distinct from the practical laws of body or mind, attribute any very high importance to them. The speculations of the metaphysician respecting duration are among the most important of this class, and with the selection of some remarks on the subject from Belsham's Elements we shall close this article.—A succession of sensations and ideas is continually passing through the mind, during the state of vigilance, the knowledge of which we attain by consciousness. The idea of succession is acquired by reflecting upon this train of ideas and sensations, and from no other source. The velocity of the succession of ideas in the same person, is different at different times; and the variation is sometimes voluntary, and sometimes involuntary. The velocity of sensations must always correspond with that of the external impressions: that of ideas depends very much upon the state of the body; they seem to succeed each other with greater rapidity in the evening than in the morning, in youth than in age, in health than in sickness, in a cheerful frame of mind than when under depression. The course of ideas is in some degree obedient to voluntary efforts; but no effort can retain one in the mind beyond a very short time, nor can we call up any given number in a given time.

143. Duration, as applied to any finite being, signifies continued successive existence. The idea of duration is acquired from reflecting upon the succession of our ideas. While this succession continues, we are conscious of the continuance of existence; when it is suspended or forgotten, the consciousness of existence, and the idea of duration is proportionably interrupted. Also, any portion of duration appears longer or shorter in exact proportion to the number of ideas which are recollected in a given interval. While we ourselves continue to exist, we perceive that other beings, whether similar or dissimilar to ourselves, also continue to exist: hence we transfer the idea of duration, and even of successive duration, to them and to all other beings that exist; and duration becomes a measure common to universal existence.—Duration is either limited, or unlimited. Limited duration is time; unlimited is eternity.—Duration, like space, can only be measured by itself; but it wants an advantage which extension possesses, and which arises from the possibility of applying one portion of it to another. The time that any one idea continues in the view of the mind is an instant; and during it we are insensible of duration, the very notion of which implies succession. The most natural measure of time, is the number of ideas recollected to have intervened between any two given instants; and when all other measures are wanting, this will answer tolerably well. Equable successions really existing, and regularly returning serve as the most correct measures of time; such are the revolutions of the

heavenly bodies, which being also various, and publicly visible, have been universally adopted, as the most convenient measures of time. These are however only the measures of duration, and not duration itself, which is the succession of ideas.

144. If the continued succession of ideas constitute the true duration of intelligent beings similar to ourselves, it will follow: 1. That if thought be suspended between death and the resurrection, the two instants will appear to be contiguous, and with respect to every individual, will actually be so. 2. That the duration of the existence of an intelligent being is to be measured, not by the revolutions of the heavenly bodies, but by the number of ideas which pass through his mind in the course of his life. 3. That an Omnipotent Being, by increasing the velocity of the succession of ideas, may cause the same revolution of the heavenly bodies which appears as a day to one, to appear as more than a thousand years to another. 4. That if a being in all other respects constituted like ourselves, should have all his ideas at once present to his mind, without any succession, he could form no conception of successive duration. 5. That to an all-perfect mind, all whose ideas are equally, invariably, and at all times present, the attribute of successive duration can with no propriety be ascribed.

PHILOSOPHY, *moral.* 1. Since much of the happiness of this life, much of our ability to benefit others, since, in short, the happiness of a boundless existence depends upon the proper regulation of our conduct and affections, surely it must be an object of the first importance that we should learn the regulation to which they should be submitted. To know our duty, and to practise it, are indeed two different things; but to practise our duty well certainly requires that we should know it well.

2. How shall we know it? Shall we consult the law of the land, or make the general conduct of mankind our guide? shall we bend our actions implicitly and constantly to the rules of holy writ, or follow invariably the dictates of our consciences? All these may be valuable, some are of inestimable value; but they do not supersede the necessity of moral investigation.—The law of the land, as Paley justly observes, labours under two defects considered as a rule of life. First, human laws omit many duties, because they are not objects of compulsion, such as piety to God, bounty to the poor, forgiveness of injuries, education of children, gratitude to benefactors. The law never speaks but to command, nor commands but where it can compel; consequently those duties which by their nature must be voluntary, are left out of the reach of the statute book, as lying beyond the reach of its operation and authority. Secondly, human laws permit, or which is much the same thing, leave unpunished many crimes because they cannot be settled by any previous description; such as luxury, prodigality, partiality contrary to the good of others, &c. For it must either settle the crime to be punished, or leave it to the magistrate to settle it; which is in effect leaving it to the magistrate to punish or not to punish at his pleasure.

3. The general conduct of mankind cannot be a safe guide. Scarcely is there a crime for which we may not find a justification in the general conduct of large societies; scarcely a disposition, however pernicious to individual happiness, which may not receive conformation from its allowed indulgence among whole nations. The bulk of mankind do not possess those advantages which enable those of cultivated minds to see almost at a glance the path of duty. What culture they have is often unskilfully applied; and therefore bad habits gain strength, and false notions of honour, pleasure and interest, occupy their minds: they think less of what is right than of what will not expose them to punishment; and their consciences are seldom consulted even where its decisions would be right.

4. To the rules of the scriptures we may indeed implicitly submit. He who steadily cultivates the dispositions which christianity enjoins, and conforms his conduct to its sacred precepts, cannot fail to mount high in the scale of moral worth. But this does not prevent the value of moral investigation. For in the first place it gives greater promptitude to our obedience, to perceive that those dictates are imperfect consistency with the laws of human nature; that an acquaintance with the laws of human nature, leads us to the conclusions forced upon us by the scriptures, that we should make the love of God, the love of our neighbour, and the law of our hearts, the guide of our actions, and of our affections.—But secondly, the precepts of christianity are very general. This is absolutely necessary to render them of use as the guide of life. Were they voluminous as the laws of England, and the decisions of the supreme courts of justice,

(which are said to fill at least fifty folio volumes,) they could not contain all the cases that would occur; for, as Paley observes, "it is not once in ten attempts that you find the case you look for in any law book whatever; to say nothing of those numerous points of conduct concerning which the law professes not to prescribe or determine any thing." Were the rules of scripture equally particular, they would be useless from their extent; and they would be injurious too, because they would prevent the reference of our actions to the general principle, and we should be satisfied if our case were not stated in the christian system of morals.—Again, thirdly, it follows from the christian precepts being so general, and principally regarding dispositions, that it not unfrequently requires some consideration to ascertain where they are directly applicable, and still more, whether they altogether coincide with one another in their direction. The virtuous dispositions may dwell together without opposition; a man may be generous and grateful and just: but the actions to which each prompts, may not have that consistency with one another, which would permit of their being brought into exercise; thus an external action which generosity and gratitude may solicit, justice may forbid. Hence it is of great importance to be able to form such a set of decisions, or still better such principles for decision as might present themselves when called for, and prevent us from giving to each class of virtuous actions, a disproportionate attention; as should enable us to decide, when actions required it, to which class of virtue our preference should be given, where we ought to restrain the impulse of feeling, and where to allow it to be our unhesitating guide.—Besides, fourthly, as Paley justly remarks, the scriptures commonly pre-suppose in the persons to whom they speak a knowledge of the principles of natural justice; and are employed not so much in teaching new rules of morality, as in inforcing the practice of it by new sanctions, and by a greater certainty, which last seems to be the proper business of a revelation from God, and what was most wanted.

5. But it may be thought there is a principle in the human mind which supersedes the necessity of moral investigation; which infallibly directs right even in the most minute circumstances. We know of no such principles. We know that there is a principle which springs up more or less in the mind of every human being, and which prompts to certain actions, and to avoid certain actions; but we cannot think that the conscience is to be regarded in the light of a blind instinct: this would degrade the moral actions of man to a level with the instinctive actions of the brute; and it is unnecessary to resort to the supposition; its existence, its variations, its effects can be accounted for without it. See PHILOSOPHY, *mental*.

But in whatever light we regard the conscience, it is indisputable that its dictates are not uniformly the same in any mind, and that they are exceedingly variable, if not with respect to the grand principles of duty, with respect to the application of those principles in different individuals and classes of individuals. It is indisputable that the moral principle grows to maturity from a small seed. It is indisputable that it is susceptible of culture; that if neglected its judgments become wavering and important; that if its dictates be made to undergo revision, if corrected by the means of judgment which we possess, if its defects are supplied by those extended views of duty, its decisions become more firm, and in general more efficacious.

6. Even an ardent desire to keep with exactness the best rules of duty will not render unnecessary attention to the cultivation of the conscience, and must therefore prompt to it. An instance occurs in point. Dr. Cogan, in his Treatise on the Passions, has the following remarks. "An instance of the influence of perverted principle occurs to my remembrance, in the conduct of a pious mother towards a most excellent and dutiful son, who, from a principle of conscience, in opposition to his interests, renounced the religious system in which he had been educated, for another which he deemed more consonant to truth. She told him that she found it her duty, however severe the struggle, to alienate her affections from him, now he had rendered himself an enemy to God, by embracing such erroneous sentiments. My friend added, that she was completely successful in these pious endeavours; and that the duty which she enjoined upon herself was scrupulously performed during the remainder of her days." The same philosophic writer adduces another instance of the irregularity of the moral principle in a young lady, in whose character mildness and compassion were pre-eminent features. "I was once passing through Moorfields," says the Doc- "tor, with a young lady, aged about nine or

ten years, born and educated in Portugal, but in the Protestant faith; and observing a large concourse of people assembled around a pile of faggots on fire, I expressed a curiosity to know the cause. She very composedly answered, I suppose it is nothing more than that they are going to burn a Jew."

7. Need we proceed? is it not a truth indisputable as that we are living for a purpose beyond mere present gratification, "that moral excellence is the true worth and glory of man, and that therefore the knowledge of our duty is to every man, in every situation of life, the most important of all knowledge?"—Now moral philosophy is that science which teaches men their duty, and the reasons of it. We should be happy if our limits allowed us to enter minutely into this important subject; but we must content ourselves with laying before our readers, such a view of those fundamental principles which are derived from the laws of our mental frame, as may furnish a guide and introduction to more extensive moral speculations, and may serve as a basis on which to found our "rule of life." In doing this, we shall make frequent and free use of the invaluable part of Hartley's observations which bears that title. We do not think it necessary to state where we have him: those who are acquainted, or who may be led by what we here state to an acquaintance, with his rule of life, will easily perceive what we owe to him; and to others it would be useless. We also acknowledge our obligations to Mr. Belsham's "Elements of Moral Philosophy," which, (though we think in one or more of his statements, page 370, he has not enough attended to the power of the disinterested benevolent affections), we wish to recommend to the perusal of our readers. These, with Paley's "Moral Philosophy," in connection with Pearson's remarks and annotations on that work, will, we think, form a pretty complete course of reading on moral science, and will amply repay the attention given to them.

8. The chief questions in morals may be reduced to three. What is that quality of conduct, affections, or character, which render them obligatory upon a reasonable being constituted like man? What are those affections, conduct, and character, which possess this quality? What are the best means for the performance of that conduct, and the acquisition of those affections and that character?—The first of these we shall now proceed to consider.

Moral Obligation. The Criterion of Virtue.

9. The term obligation respects voluntary actions only. We say we are obliged to walk if we wish to have health: we are obliged to regular exertion if we wish to acquire valuable mental habits; we are obliged to perform certain actions in order to attain certain ends.—The use of the term in this and similar situations suggests its true import. Obligation expresses the necessary connection existing between a certain end and a certain means. Thus, if that end be the possession of health, the necessary means are, that we take exercise: if the end be the formation of valuable mental habits, a regular series of exertions is the necessary means; and, in short, in whatever case we wish to express that certain ends can only be obtained by certain means, we say we are obliged to use these means, in order to obtain these ends.

10. Obligation differs from compulsion. The former respects voluntary actions, the latter involuntary. Compulsion always implies some external force. Thus, a man is obliged in honour to pay his debts, and if he do not he will be compelled by the law: that is, if to satisfy the calls of honour be the end, the payment of his debts is the necessary means; if this obligation operate not sufficiently strongly as a motive, he will be compelled to do it against his will by the law.

11. Obligation by no means implies an obliger. I may be obliged by reason, by interest, by convenience, by honour, by conscience, &c. as well as by the authority of another. Authority is one, but not the only source of obligation.

12. Moral obligation respects those actions which are denominated virtuous or vicious; we are obliged to perform the one, and to abstain from the other, because this is the necessary means, in order to effect a certain end, or certain ends. That is to say, unless we do practise virtue, and abstain from vice, we cannot obtain the end which wisdom points out as deserving pursuit.

13. As has been remarked of obligation in general, there may be various sources of moral obligation; that is, a person may be obliged to the performance of his duty by the laws of God, the dictates of his conscience, the hopes and fears of immortality.

Whatever can be pointed out as the ultimate obligation, that is, that to which all others may be reduced, will also furnish the most general criterion of duty. Thus, if it appear that the ultimate obligation to virtue is the greatest happiness of the agent, then we should say, that virtue is that quality of an action, or affection, or character, by which it tends to the greatest happiness of the agent. In other words, a certain character of action or disposition is a necessary mean to a certain end; that end may be various: suppose the ultimate end, or that to which all others are to be referred, is the greatest happiness of the agent, then it follows, that the tendency to the greatest happiness of the agent is that criterion by which we are to ascertain whether or not it is obligatory. To such a tendency we give the denomination of virtue.

14. Many sources of obligation have been pointed out by different philosophers. That is, to the question, Why ought I to act in a certain way which we call virtuously? many answers have been given. Some of the most important are the following.

15. It is agreeable, say some, to the eternal and necessary fitness of things.—This leaves the distinction between virtue and vice altogether arbitrary; for it depends upon the perception of a fitness or unfitness, which can only be ascertained by investigations, whose conclusions will differ in different individuals. Besides, it has justly been asked, What are those moral fitnesses fit for? If the fitness or unfitness of actions means any thing different from their tendency to produce happiness or misery, the expression is unintelligible. We may safely use the expression, for there is certainly a beauty and propriety in virtue, which increases in our estimation as virtue itself gains an influence in our breasts; but still when we speak of it as an obligation, we find the question returning, Why ought I to act agreeably to the fitness of things?

16. It is agreeable, say others, to the dictates of right reason.—Unless you can show me a reason independently of your assertion, in what way am I bound to comply with what you call the rules of virtue? Besides, in what respect can an action be said to be agreeable to the dictates of right reason, but as it possesses some tendency to something? and what that something is, it leaves us to estimate for ourselves, and consequently does not bring us to the ultimate obligation which we are inquiring for.

17. It is the opinion of some, whose own confirmed habits of virtue probably were in some measure the cause of the opinion, that virtue carries in itself its own obligation; that the understanding represents a certain action, or set of actions, as right, and that therefore it ought to be performed.—It is objected, with great justice to this system, that it leaves the matter where it found it; for the question recurs, Why am I obliged to perform an action which my understanding represents to me as right? Further, it is arguing in a circle. My understanding represents such an action as right; that is, obligatory; and therefore I am obliged to perform it. Why does my understanding represent this action as right? Besides, it refers to a kind of infallible judge within, whose dictates appear, in fact, to be very different in different persons. Felton believed that he did what was right, that, in short, he performed an action which was highly meritorious, when he murdered the duke of Buckingham. According to this, he was under an obligation to do it.—There cannot be a doubt that it is the part of true wisdom to endeavour to cultivate the moral powers, and then leave the actions entirely (except in extreme cases) to their suggestions. But to state, that an action is obligatory, because the understanding, or the conscience, (for it comes to the same thing) represents it as right, is to sanction as virtuous, some of the most depraved actions; for some of the most depraved actions have been performed by those who thought it right to perform them.—The fact appears to be, that the advocates for this system, having spent much of their lives in cultivating their moral ideas, and finding them always correct, have acquired the habit of acting implicitly upon them, and hence have judged, that because they were represented by our conscience as right, therefore they were obligatory. This appears a sufficient obligation for those who have well-cultivated consciences; but it will answer in no other cases, and the question still recurs, Why is this action obligatory?

18. Because, say others, it is agreeable to the dictates of the conscience.—The observations under the last head have anticipated what might be made here. When we analyze the grounds of the moral feelings and sentiments, (see PHILOSOPHY, *mental*). We shall see, that they cannot be safely made the infallible rule of our conduct, still less can they furnish the ground of obligation.—It cannot, however,

be too strongly impressed upon the mind, that correct dictates, and the exaction of implicit obedience to those dictates, constitute the perfection of the conscience.

19. But when we say, it is agreeable to the will of God, we seem incapable of advancing further. We surely are obliged to perform the will of God by every consideration.—Most true, and yet we are not come to the last obligation. Even in the sentence we have just used, we have, without intending it, referred to some other.—Under the dominion of a wise and good God, there cannot be a doubt, that obedience to his commands is the highest wisdom; but why? It is a question that admits of an answer, and may therefore be put, though reverently: Why am I obliged to do the will of God? And the answer is obvious. Obedience to the commands of a benevolent God must be productive of the greatest ultimate happiness.—Not that it is necessary frequently to take this into consideration; for when we have ascertained that we are walking surely, we may walk safely without that degree of attention which, before such ascertainment, might have been necessary. To obey the will of God in all things is the highest point of wisdom; and he is most obedient who obeys because he loves.

20. Every question, Why is any one obliged to perform a certain action? gives us an ultimate answer; because it tends to the greatest ultimate happiness of the agent. When we arrive at this point it is obvious we can go no further.—And, though true wisdom undoubtedly directs, that in order to attain the highest point of moral excellence, we must leave our own happiness out of consideration, yet there cannot be a doubt, that there could be no obligation to any conduct in opposition to happiness on the whole.—If self must be annihilated, it is because self-annihilation, or self-oblivion, is necessary for the attainment of the highest possible happiness.—Here, then, we come to the ultimate obligation, and upon this ground we shall build our moral superstructure. Though the principle appears a selfish one, it will be found, that the deductions from it are completely the reverse.—It has been remarked in favour of this as the ultimate obligation, that no nearer obligation could ever be admitted, which cannot at last be resolved into this ultimate one: that happiness is the end of the whole creation, though the means by which it is to be obtained are not always in themselves happiness; and that revelation itself assumes this as the ultimate reason of all its requisitions.

21. We now proceed to the second enquiry (§. 8.) What are those affections, conduct, and character, which tend to the greatest ultimate happiness of the agent; and in considering this the third will receive an answer. We shall chiefly confine our inquiries to the affections, for the reason already stated (§. 7.) and we shall make an estimate of the value of the different pleasures and pains of the mind. This will lead to what we deem an indisputable conclusion, from the laws of the mental frame, that the love of man, of God, and of duty, (in other words, the affections of benevolence and of piety, and the moral sense,) should be the primary objects of our aim; and this because he will be most happy in whom those affections exist in the greatest strength and vigour. We have already stated (PHILOSOPHY, *mental*, §. 73—99.) the Hartleyan classification of feelings; and we shall here presuppose that our readers are aquainted with it.

I. ESTIMATE OF SENSIBLE PLEASURES.

22. The first pleasures and pains of the human being are obviously those of sensation, and they form one source of enjoyment, and still more of suffering, during the whole of life. It is from these that the whole round of mental or intellectual pleasures and pains is composed.—To estimate the value of these pleasures, in their uncompounded state, take the extreme case, that any one pursued them as a primary object, laying aside all restraint from the virtues of temperance and chastity, he would soon destroy his bodily faculties, thus rendering the objects of sensible pleasure useless; and he would precipitate himself into pain, diseases, and death, evils of the first magnitude in the eyes of the voluptuous. "This is a plain matter of observation, verified every day by the sad example of loathsome, tortured wretches that occur which way soever we turn our eyes, in the streets, in private families, in hospitals, in palaces." Positive misery, and the loss even of sensible pleasure, are too inseparably connected with intemperance and lewdness to leave room for doubt even to the most sceptical.—The sensual appetites must therefore be regulated by, and made subservient to, some other part of our natures, else we shall miss even the sensible pleasure which we might have enjoyed, and shall fall into the opposite pains, which are in general far greater

and more exquisite than the sensible pleasures.

23. The same conclusion also follows from the fact, that inordinate indulgence in sensual gratifications destroys the mental faculties, exposes to external inconveniences and pains, is totally inconsistent with the duties and pleasures of benevolence and piety, and is all along attended with the secret reproaches of the moral sense, and the horrors of a guilty mind. Such is the constitution of our mental frame, that the formation of mental feelings and affections cannot be altogether prevented; but that an inordinate pursuit of sensible pleasures converts the mental affections into a source of pain, and impairs and cuts off the intellectual pleasures.

24. The same thing may be concluded from the fact, that the sensible pleasures are formed first, and the mental pleasures from them by the associative power. Now it is a general principle in the order of nature, that the prior state or means is less perfect and important than the posterior state or the means. Hence the sensible pleasures cannot be of equal value and dignity with the mental, to the generation of which they are made subservient.—This inference may be drawn from the analogy of nature, without reference to the infinite benevolence of the Supreme Being, which, however, makes it more satisfactory.

25. Farther, the mental pleasures are more consistent with the gentle, gradual decay of the body, than the sensible pleasures, because, as they are formed from the combination and coalescence of many sensible pleasures, they more affect the sensible system at large; while the sensible pleasures principally affect the particular parts of the system to which they belong, and therefore when indulged to excess they injure or destroy their respective organs before the whole body comes to a period.

26. Lastly, the duration of mere sensible pleasure is necessarily very short, and cannot, even when free from guilt, afford any pleasing recollections; whereas one of the principal tendencies of our nature is, and must be, the pleasures of reflection and consciousness. In like manner, the evident use and restriction of one of the chief sensible pleasures to preserve life and health, with all the consequent mental faculties and executive bodily powers; of the other to continue the species, and to generate and enlarge benevolence, makes the subordinate nature of both manifest in an obvious way.

REGULATION OF THE PURSUIT OF SENSIBLE PLEASURES.

27. The foregoing remarks prove, that the pleasures of sensation ought not to be made the primary pursuit of life, but require to be regulated and restrained by some foreign regulating power. That they should be submitted to the precepts of benevolence, piety, and the moral sense, may be proved by shewing, that by this means they will contribute both to their own improvement, and to that of other parts of our natures.—Now benevolence requires, that the pleasures of sense should be made entirely subservient to health of body and of mind, so that each person may best fill his place in life; best perform the several relative duties of it; and, as far as in him lies, prolong his days to their utmost period free from great diseases and infirmities. All gratifications, therefore, which tend to produce diseases of body, or irregularities of mind, are forbidden by benevolence, and the most wholesome diet as to quantity and quality enjoined by it. It also most strictly forbids all gratifications by which the health or virtue of other individuals is injured, or by which encouragement is given to others to depart from the rules of chastity and temperance.—The precepts of piety are to the same purpose, whether they are deduced from our relation to God, as our common father and benefactor, who wills that all his children should use his blessings so as to promote the common good; or from the natural manifestations of his will in the immediate pleasures and advantages arising from moderate refreshment, and the manifest inconveniences and injuries caused by excess in quantity or quality; or from his revealed will, by which temperance in all sensible pleasures is commanded, and intemperance severely threatened.—In like manner the moral sense directs implicitly to the same moderation, whether it be derived explicitly from the foregoing rules of benevolence and piety, or from ideas of decency, rational self-interest, the practice of wise and good men, the disgusting nature of the diseases consequent on intemperance, the odiousness and mischief of violent passions, &c. It is evident, therefore, that all these guides of life lead to the same end, viz. great moderation in sensible enjoyments, though they differ somewhat in their motives, and in the commodiousness of their application, as a rule in the particular occurrences of life.

28. By this steady adherence to mode-

ration, we are no losers even with respect to sensible pleasures themselves; for by these means our senses and bodily powers are preserved in their best state, and as long as is consistent with the necessary decay of the body; and this moderation, and its beneficial consequences, directly tend to inspire the mind with perpetual serenity, cheerfulness, and good-will, and with gratitude to the giver of all good. —In the common intercourse of life, associated circumstances add greatly to the pleasures of sensation: thus the pleasure of receiving a thing from a friend, or sharing it with a friend, sociality and mirth at the time of enjoyment, &c. greatly enhance the gratifications of taste. Much more then will the pure and exalted pleasures of piety and benevolence increase these pleasures.

29. We are, then, great gainers on the whole by religious moderation as to sensible pleasures; still more so as to the sensible pains and sufferings which the intemperate bring on themselves. These are of the most exquisite kind, and often of long duration, especially when they give intervals of respite. They impair the bodily and mental powers, so as to render most other enjoyments insipid and imperfect; they dispose to peevishness, passion, and murmuring against Providence, and are attended with the pangs of a guilty mind.—On the whole, the proper method of avoiding the sensible pains, whether the result of excess, or such as occur in the daily discharge of the duties of life, and of obtaining the sensible pleasures in their best and most lasting state, is not to aim at either directly, but in every thing to be guided by the dictates of benevolence, piety, and the moral sense. It is evident that luxury, self-indulgence, and an indolent aversion to perform the duties of a man's station, not only bring on gross bodily diseases, but previously to this, often produce such a degree of anxiety and fearfulness in minute affairs, as to make persons inflict upon themselves greater torments than the most cruel tyrants could inflict.—There are cases, however, in which persons are obliged, from a sense of duty, from benevolence, from adherence to true religion, &c. to forego pleasure, and to endure pain; and this, where there is no probability of a recompense in this life. Here the hopes of futurity lend their aid; and the present pleasure which these afford, is in some cases so great, as to overpower, and almost to annihilate the opposite pains.

Rules respecting sensible Pleasures.

30. "The only rule with respect to our diet," says Dr. Priestley, in his Institutes, "is to prefer those kinds, and that quantity, of food, which most conduce to the health and vigour of our bodies. Whatever in eating or drinking is inconsistent with, and obstructs this end, is wrong, and should carefully be avoided; and every man's own experience, assisted with a little information from others, will be sufficient to inform him what is nearly the best for himself in both these respects; so that no person is likely to injure himself through mere mistake."

31. It is sufficiently obvious, that it is the benevolent affections which give the chief value and highest interest to the sensible pleasures arising from the intercourse of the sexes; and it also appears that these pleasures were designed by the great Author of our frame, to be one chief means of transferring our affection and concern from ourselves to others. If, therefore, this great source of benevolence be corrupted or perverted, the social affections depending on it will also be perverted, and degenerate into selfishness or malevolence. These considerations of themselves point to marriage as the only justifiable mode of indulging the sexual passion.—Unrestrained promiscuous intercourse would produce the greatest evils public and private: by being unrestrained, it would destroy the health, and prevent the propagation of the species; by being promiscuous, it would be ineffectual to promote the tender and benevolent charities either between the individuals themselves, or towards their offspring, and would produce endless contentions among mankind. Now, though scarcely any known nation has allowed of such entire licentiousness, yet the evils arising from any great degree of it, are so abundantly obvious and important, that they have almost universally led to some such regulation of sexual intercourse as that of marriage, and prove its necessity for the well-being of society.—Further, (to use the words of Paley, whose excellent remarks on this subject we shall freely employ, as suits our purpose), the public use of marriage institutions, also, consists in their promoting the production of the greatest number of healthy children, their better education, and the making of due provision for their settlement in life; and, in their promoting the private comfort of individuals, and particularly of the female sex. It may be true, all are not interested

in this last reason: nevertheless, it is a reason to all for abstaining from any conduct which tends, in its general consequence, to obstruct marriage; for whatever promotes the happiness of the majority, is binding upon the whole.—These considerations prove that the restraint of marriage-institutions is an essentially important obligation. It may be violated by vagrant concubinage, or by cohabitation limited to a single individual. The former will be the object of the next paragraph: the latter cannot be placed upon the same footing with it, in several respects; but as it can answer the primary public ends of marriage in only a few cases, as it tends to annihilate the individual advantages which are naturally derived from it (both as to moral welfare and to comfort), and as it decidedly discountenances marriage, and consequently, in the present state of society, countenances fornication, it follows that it is immoral. "Laying aside the injunctions of the Scriptures," says Paley, "the plain account of the question seems to be this: it is immoral, because it is pernicious, that men and women should cohabit, without undertaking certain irrevocable obligations, and mutually conferring certain civil rights; if, therefore, the law has annexed these rights and obligations to certain forms, so that they cannot be secured or undertaken by any other means, which is the case here (for whatever the parties may promise to each other, nothing but the marriage ceremony can make their promise irrevocable), it becomes in the same degree immoral, that men and women should cohabit without the interposition of these forms."

32. With respect to the crime of fornication, it is to be observed, that promiscuous concubinage tends greatly to discourage marriage, and therefore to defeat the several beneficial purposes spoken of in the last paragraph. The reader will learn to comprehend the magnitude of this mischief, by attending to the importance and variety of the uses to which marriage is subservient; and by recollecting that the malignity and moral quality of each crime is not to be estimated by the particular effect of one offence, or of one person's offending, but by the general tendency and consequence of crimes of the same nature. If one instance of licentious indulgence be innocent or allowable, why should not more? and if allowable in one, why should not licentiousness become general? and if it were so, what dreadful consequences would follow? Every instance of licentious conduct has the direct and decided effect of leading to these dreadful consequences (which none but a purely malevolent being could contemplate without horror); and every instance is therefore criminal, altogether independent of its individual effects and tendencies.—Again, fornication supposes prostitution; and prostitution brings and leaves the victims of it to almost certain misery. It is no small quantity of misery in the aggregate, which, between want, disease, and insult, is suffered by those outcasts of human society who infest populous cities: the whole of which is a general consequence of fornication, and to the increase and continuance of which every act and instance of fornication contributes.—Further, fornication produces habits of ungovernable lewdness, which introduce the more aggravated crimes of seduction, adultery, violation, &c. Of this passion it has been truly said, that irregularity has no limits; that one excess draws on to another; that the most easy, therefore, as well as the most excellent way of being virtuous, is to be so entirely. However it be accounted for, the criminal intercourse of the sexes corrupts and depraves the mind and moral character more than any single species of vice whatsoever. That ready perception of guilt, that prompt and decisive resolution against it, which constitutes a virtuous character, is seldom found in persons addicted to these indulgences. They prepare an easy admission for every sin that seeks it; are, in low life, usually the first stage in men's progress to the most desperate wickedness; and, in high life, to that lamented dissoluteness of principle which manifests itself in a profligacy of public conduct, and a contempt of the obligations of religion and moral probity. Add to this, that habits of libertinism incapacitate and indispose the mind for all intellectual, moral, and religious pleasures; which is a great loss to any man's happiness. —Lastly, fornication perpetuates a disease, which may be accounted one of the sorest maladies of human nature; and the effects of which are said to visit the constitution of even distant generations.—The passion being natural, proves that it was intended to be gratified; but under what restrictions, or whether without any, must be collected from other considerations.—If fornication be criminal, all those incentives which lead to it are accessaries to the crime, and as such are criminal (independently of their injurious effects upon the mind, which how-

ever are very great); for instance, lascivious conversation, whether expressed in obscene, or disguised under modest, phrases; also wanton songs, pictures, and books; the writing, publishing, and circulating of which, whether out of frolic, or for some pitiful profit, is productive of so extensive a mischief, from so mean a temptation, that few crimes, within the reach of private wickedness, have more to answer for, or less to plead in their own excuse.

33. Though the sexual desires are very strong, yet there is abundant reason to believe that they are not originally much disproportionate to their end; and that if due care were taken they would not arise in youth much before the proper time for this end. But the violence and unseasonableness of these passions are so manifest in the generality of young persons, that one cannot but conclude the general education of youth to be grossly erroneous and perverted: and this will appear very evident, in fact, upon examination. The diet of children and young persons is not sufficiently plain and sparing; a proper regulation of which would lay a better foundation for health, and freedom from diseases, and put some check upon these passions. They are brought up in effeminacy, and neglect of bodily exertion, which would materially assist to prepare both body and mind for the discipline of life, and would restrain the sexual passion. The due culture of the mind, especially in respect of religion, is very generally neglected; so that the young are usually left without employment for their thoughts, and destitute of the chief armour, that of religious motives, whereby to oppose temptation. Lastly, the conversation which they hear, and the books which they are allowed to read, are so corrupt, in this respect, that it is a matter of astonishment how a parent, who has any serious concern for his child, can avoid seeing the immediate destructive consequences, or think that any considerations relating to this world can be a balance to them.

II. ESTIMATE OF THE PLEASURES OF IMAGINATION.

(PHILOSOPHY, *mental*, § 73, 74.)

34. It does not appear from actual experience, that those who devote themselves to the study of the polite arts, or of science, or to any other pleasure of mere imagination, as their chief end and aim, do attain any greater degree of happiness than the rest of the world. The frequent repetition of these pleasures cloys, as in other cases; and though the whole circle is extensive, yet no one can grasp the whole, and as a matter of fact few apply themselves to more than one or two considerable branches. —From the manner in which the feelings of imagination are usually generated and transferred upon their several objects, it might be expected that deformity would often be mixed with beauty, so as to produce an unpleasing discordancy of opinion, even in the same individual; and, as a matter of fact, it is not uncommon for men, after a long and immoderate pursuit of one class of beauty, natural or artificial, to deviate into such by-paths and singularities, that the objects excite rather pain than pleasure; their limits for excellence being narrow, and their rules absurd, and all that falls short of these being condemned by them as deformed and monstrous.—Eminent votaries of this kind are generally remarkable for ignorance and imprudence in the common affairs of life, thus subjecting themselves to ridicule and contempt, and to real, great, and lasting inconveniencies. —Vanity, moroseness, and envy, are too generally the concomitants of an over-weening attention to the pursuit of these pleasures. And scepticism in religious matters is too frequent an attendant here, which, if it could be supposed free from danger as to futurity, is at least very uncomfortable as to the present. The almost necessary consequence of such confined attention is, that too high a degree of importance is given to the object, and the superiority which is supposed to be possessed in it, is supposed also to extend to other cases in which the individual is perhaps uncommonly ignorant; and thus he either becomes dogmatical or sceptical; qualities which, though apparently different from each other, are, in reality, to be considered as antecedent and consequent, dogmatism being frequently followed by scepticism. And as religious knowledge, to be properly cultivated, requires that the soil should be prepared by the benevolent and pious affections, and no kind of learning being of itself sufficient to give this preparation, if attention to the pursuit of literature or of science be so inordinate as to suppress the growth of these affections, religion itself will be treated as incomprehensible, absurd, uncertain, or incredible.—However, it is difficult to represent justly, what is the genuine consequence of the pursuit of the mere pleasures of the imagination, their votaries

being also generally actuated by motives of ambition; but, as will be seen hereafter, this does not invalidate any of the foregoing remarks.—It is justly observed by Dr. Percival, that the endless progression of knowledge is apt to give the love of it an inordinate ascendancy over every other principle; and as this passion does not, like the love of virtue, temper its particular exertions, by preserving a due subordination of the powers which it calls into action, the wildest extravagancies of emotion and of conduct, have been displayed by those who have submitted to its uncontrouled dominion.

35. Further, we have reason to suppose that the pleasures of imagination ought not to be made our chief end and aim, because in general they are the first of the intellectual pleasures, come to their height early in life, and decline in old age. There are some few indeed who continue devoted to them through life; so there are some to the pleasures of sensation, but both are irregularities which cannot be considered as indications of the designs of Providence respecting these pleasures. Hence the argument (§ 24.) is applicable to these pleasures also. Like every other part of the great machine, they have their use, but it is a subordinate one; they tend to the improvement and perfection of our nature, but eminence in them is not that perfection. They teach a love of regularity, exactness, truth, simplicity; they lead to a knowledge of many important truths respecting themselves, the world in general, and its Author: they habituate to invent and to reason; and when the social, moral, and religious affections begin to be generated in us, we may make a much quicker progress towards the perfection of our natures by having a due stock, and no more than a due stock, of knowledge in natural and artificial things, of a relish for natural and artificial beauty.

Regulation of the Pleasures of Imagination.

36. As the pleasures of imagination are manifestly intended to generate and augment the higher orders of benevolence, piety, and the moral sense, so these last may be made to improve and perfect the former.—Those parts of the arts and sciences which inspire us with devout affections, and enable us to be most useful to others, abound with the most and greatest beauties. Thus the study of the scriptures, of natural history, and natural philosophy, of the frame of the human mind, &c. when undertaken with pious and benevolent intentions, lead to more interesting and surprising truths, than any study intended for mere private amusement.

37. Further, since the world is a system of benevolence, and consequently the Author of it is the object of unbounded love and adoration, benevolence and piety are the only true guides into our inquiries into it, the only clues which will lead through the labyrinths of nature. In the pursuit of every branch of valuable knowledge, let the inquirer take for granted that every thing is right on the whole, that is, let him with a pious confidence seek for benevolent purposes, and he will find the right road, and, by a due continuance in it, attain to some new and valuable truth; whereas every other principle and motive for examination, being foreign to the great place upon which the universe is constructed, must lead to endless mazes, errors, and perplexities.—Again, it is to their tendency to the increase of happiness that almost all truths owe their lustre. Hence those whose minds are under the influence of benevolence, will have the highest gratification which the perception of those truths can produce.

38. Lastly, the pleasures of the imagination point to devotion in a particular manner from their unlimited nature. All the feelings derived from beauty, both natural and artificial, begin to fade and languish after a short acquaintance with it; novelty is a never failing requisite; we look down with indifference upon what we comprehend easily, and feel the wish to aim at such things as are but just within the compass of our present faculties. To what inference does this tendency to press forwards, this endless grasping after infinity, necessarily lead us? Is it not that the infinite Author of all things has so formed our faculties, that nothing less than himself can be an adequate object for them: that nothing finite, however great and glorious, can afford full and lasting satisfaction: that as nothing can give us more than a transitory delight, if its relation with God is excluded, so every thing, when considered as the production of his infinite wisdom and goodness, will gratify our utmost expectations, since in this view we may rest satisfied that every thing has numerous uses and excellencies, and that in the course of nature the least and vilest, according to common apprehension, bear a proper part, as well

as those whose superiority over them is very great.—In fine, then and then only is science a worthy object of pursuit, as a primary object, when it is pursued with just views; when it is valued for its tendency to form valuable mental habits, and to cultivate moral ones; when we appreciate its value by its enlarging our capacity of usefulness to our fellow men, and by its enabling us to raise our minds from sense to intellect; when we make it the path to religious and moral worth. As a means, it is highly conducive to the purification and perfection of our nature; pursued as an end, it will engross the affections, and the more noble and fascinating, than the sordid or sensible pleasures, will by degrees become a more dangerous and obstinate evil than those.

III. ESTIMATE OF THE PLEASURES OF AMBITION.

(PHILOSOPHY, *mental*, § 75—78).

39. That the pleasures of honour ought not to be made a primary object of pursuit, appears from the following considerations. An eager desire of the pleasures of honour, and an earnest endeavour to obtain them, has a manifest tendency to disappoint itself. The merit of actions, that is that property for which they are extolled, and the agent loved or esteemed, is that they proceed from benevolence, or some other moral or religious consideration: whereas if the desire of praise form any considerable part of the motive, we censure rather than commend. But if praise be supposed the greatest good, the desire of it will prevail over other desires, and vanity, self conceit, and pride, qualities which all regard as contemptible, will be the necessary consequents.—Again, if praise be considered as the supreme good of the species, what is there which shall be selected as the greatest subject of encomium. What is there which shall be the universal object of praise, as well as within the reach of every one. External advantages, riches, beauty, strength, &c. These are neither in the power of all, nor universally commended. Great talents, wit, sagacity, invention, these though more the subjects of encomium fall to the lot of very few only. In short virtue alone is both universally esteemed and in the power of all who are sufficiently desirous to attain it. But virtue cannot consist with the pursuit of praise, much less with its being made a primary object. Hence it ought not to be made such.—Even those who possess the advantages which are made the subject of praise, can seldom pursue praise with success. Praise cannot be the lot of many, because it supposes something extraordinary in the thing praised; so that he who pursues it must either have a very good opinion of himself, which is a dangerous quality in the seeker of praise, or allow that there are many chances against him.—The same conclusion is drawn, if we consider the progress of the pleasures of honour. Children are pleased with encomiums upon any advantageous circumstances which relate to them, but this wears off by degrees; and as we advance in life we learn more and more to confine our pleasures of this kind, to things within our own power, and to virtue. In like manner the judicious part of mankind, that is those whose praise is most valued, give it only to virtue and those feelings and habits of which virtue is the basis. Here again is a manifest subserviency of these pleasures to virtue: they not only tell us that they are not our ultimate end, but shew us what is.

40. There is something extremely absurd and ridiculous in supposing a person to be perpetually feasting his mind with the praises that already are, or which he hopes will be hereafter given to him. And yet unless a man does this, which besides would incapacitate him for deserving or obtaining praise, how can he fill up a thousandth part of his time with the pleasures of ambition.—Further, men who are much commended are apt to think themselves above the level of the rest of the world, and it is evident that praise from inferiors wants much of the high relish those expect who make praise an object: it is even uneasy and painful to a man to hear himself commended, though he may think it his due, by a person whom he does not think qualified to judge. And in this view of things a mind which has acquired truly philosophical and religious notions sees immediately that all the praises of mankind are comparatively of no value, because no man can be a thoroughly competent judge of the actions and motives of others.—Lastly, the desire of praise carries us from less to greater circles of applauders at greater distances of time and place; hence it necessarily inspires us with an eager hope of a future life. Now all reflections upon a future life, the new scenes which will be unfolded there, the discoveries which will then

be made of the secrets of all hearts, must cast a damp upon every ambition except a virtuous one, and produce diffidence even in those who have the best testimony of their conscience.

Regulation of the Pleasures of Honour.

41. We have already seen sufficient ground for the position, that it is a law of our natures, that the inferior sources of happiness are most productive of happiness when not made the primary objects of pursuit but submit to the direction of the higher means. This is eminently the case with respect to the pleasures of honour. They may undoubtedly be obtained in their highest degree, and in their greatest perfection, by paying a strict regard to the precepts of benevolence, piety, and the moral senses. —These precepts lead to the attainment of those qualites, and the performance of those actions, whose value is universally felt, and universally admitted; and at the same time preserve from that ostentatious display of them, or of other supposed grounds of honour, which would render their possessor ridiculous or contemptible. Honour is certainly affixed by the bulk of mankind to actions of benevolence, such as acts of generosity, compassion, public spirit, &c., and the encomiums bestowed upon such actions are one principal source of the feelings of the moral sense. The maximum of honour, therefore, must coincide with benevolence, and the moral sense, and consequently with piety also, which is closely connected with them. It must, however, be admitted that direct acts of piety are by no means calculated to gain the honour of the world in general, but, on the contrary, they expose to the reproach of enthusiasm, superstition, &c.; on the other hand, however, it must also be admitted, that humility, which is the principal of all the qualifications which recommend men to the world, cannot be obtained in any high degree without piety. Hence piety directly leads to the honour of men, and at the same time in proportion as piety increases in its efficacy on the mind, the fear of this censure gradually diminishes.

42. The grand source of honour, directly or indirectly, is the tendency of an action or disposition to happiness of some kind or other, occuring to a man's self, or to the world by his means. He, therefore, who is most happy in himself, and contributes most to the happiness of others, must in the end, from the very law of our natures, have the greatest quantity of honourable associations conferred upon him. But it has already appeared, in part, that benevolence, piety, and the moral sense, are the only true lasting sources of private happiness; and that the greatest public happiness arises from them cannot be doubted by any one; hence he in whom these qualities are prevalent, will as far as his character is known and understood, obtain the applause of all, both good and bad. The esteem of the good he will first obtain, because they can most easily estimate his worth; and it is this alone which is valuable and useful in exciting to honourable attainments.

43. In proportion as the views extend, and the comprehension of the mind increases, the desire of honour, esteem, and approbation, will require higher sources of gratification than that of men, even of the wise and good: it rises even to the throne of the Most High, and from him to whom all hearts are open, humbly hopes for approbation. This greatest of all honours can undeniably be obtained only by a regard to piety, benevolence, and the moral sense. If the desire of it be not the desire of our minds, it must arise from such inattention to the most important relations in which we stand, as is totally inconsistent with our true happiness; and if it become a ruling principle of our minds, all encomiums will derive their value from their consistency with the highest standard of honour.

On the Effects of Pride and Vanity.

44. Before we offer any remarks on this point, it may be requisite that we explain in what manner we use our terms, since they are employed with great latitnde, so as to throw discredit upon ethical representations respecting pride and vanity; and since by the transference of the association connected with what is called laudable pride, to a quality of the mind which in every shape of it is a vice, that abhorrence of it is diminished, which its obvious ill consequences should always produce. By pride, we understand an unjust feeling of superiority over others, or of elevation in the scale by which the individual estimates honour; by vanity, an excessive desire of the praise or good opinion of others. The former indicates an unfounded opinion as to the title to honour: the latter is generally acompanied with some opinion of that kind but does not necessarily imply more than an eager desire of it.

45. Pride and vanity may exist almost

singly in the mind: there may be those to whom their own good opinion, independently of the approbation of God, shall be every thing; and who find the sympathy of others totally unnecessary for the nurture of their own pride. In the present state of society this is not common, the good opinion of others is productive of too many important consequences ever to permit pride to be thus fostered, except where it is the effort of a strong, but ill-directed mind, to counterbalance the disappointments of vanity. He who has made the good opinion of others the primary object of pursuit, having met with its sure consequence, disappointment in his wishes, if he have not lost all his strength of mind by the weakening effects of vanity, will endeavour to rise above it; and if he have no religious principles, or but little religious culture, will dwell with gratification upon all the fancied excellencies of his own character, till they have acquired in his mind an importance to which they are little entitled: then moroseness must be the predominant feature in his temper, for he cannot bear that others should treat him with less respect than he thinks he has a right to claim; till at last an almost total unconcern for the opinion of others is forced upon his mind, and having no higher principle of action he becomes a misanthrope. It is probably doing no injustice to the character of Swift, when we mention him as having gone this round.—But this is an extreme case: pride leads a man to set too high a value upon himself; but it is only that strength of mind which, when well directed, would have led to the highest attainments in moral worth, that will permit him to rest satisfied without the sympathy from others which he supposes is his due. Hence his pride must meet with constant mortification; for where will be found those who are willing to restrain their conduct continually by the rules to which he would bind them; where even are those who can enter into his views and feelings; pride then, even in a less extreme state, cannot be productive of happiness. But its ill effects are not thus limited. Blind to his own deficiencies, keen-sighted to observe the marks of merit in his own mind, the proud man throws continual impediments in his own progress towards worth of character. He sees not his deficiencies; how then can he supply them? He imagines his excellencies have mounted high in the scale of worth; how shall he purify them, when that which prevents their eminence is fostered by every comparison which he draws?

46. It has been said by one who appears to have possessed some knowledge of the world, that pride has at least this valuable effect, it tends to exclude all other failings; for the proud man places his standard so high, that he never feels his regard to his own dignity satisfied, till all inferior feelings are extirpated. This, we apprehend, is erroneous. It is supposing a mixture of pride and humility which will never appear in that mind in which pride is the ruling feature. The man who is proud of his own excellencies seldom sees that they are defective: besides, a desire of self approbation is not pride, though too strong and unchastened a desire may tend to produce pride, because self-approbation is easily gained when made independent of higher sources.—There may be anomalies here, as in every other case of the operation of moral causes; but they are not sufficient to lead to the conclusion, that pride has the tendency to raise the mind above all other failings. Pride will operate differently in different minds, and the desire of self-approbation is, and ought to be, a primary motive in all the earlier stages of the moral progress: but if the mind rests satisfied with this approbation, that progress will soon be impeded; the standard will be lowered, rather than the conduct exalted; comparison with others will suggest numerous sources of self-gratification; and the mind, unable to rise to the heights which once appeared in view, now rather looks down upon the advances she has made, than upon the cliffs which still tower very far above her. Here then is a stop to improvement; the desire which stimulated to improvement is gratified: and he, who, had he looked beyond himself, might have risen to the summit of excellence, now rests contented on the little pinnacle which his imagination has raised, looks with contempt on the crowds below, but, wrapt in the veil of conscious superiority, sees not that numbers whom he once saw below him have risen, and are rising, while he is lost to all improvement.

47. In minds possessed of some strength, pride may exist with little or no tendency to vanity. Firmly convinced of their own worth, they need not the sympathy of others; and if that respect which they deem their due is not given, it is the last suggestion that would occur to their minds that they had mistaken their due. But in those whose

pride is less confirmed, or whose minds are more dependent, that pride leads to vanity. Their own high ideas of their own powers and attainments, require the sympathy of others to render them steady. Precisely as pride or vanity has the predominance, the want of such gratification will lead to greater independence, or greater submission; in the one case leaving the mind to the wayward wanderings of its own feelings, in the other forging more firmly the shackles which bind it to the world. Happy they who have learnt from various discipline, that higher approbation is to be sought for than the approbation of the world, or even than their own, and that neither possesses permanent value, except where sanctioned by that which, when once the ruling object of the mind, will make all others comparatively insignificant.

48. We have stated that both pride and vanity may exist independently of each other: from what we have advanced it appears, that pride will exist thus separately only in a vigorous mind, vanity, we would add, will be found independently of pride only in a weak mind. He who cannot rest satisfied without the sympathy of others, must be ever varying in his ideas, and fickle in his conduct. Without it he will possess no firmness, and with it no decision. The approbation which pride claims as its due, vanity seeks as a favour; if it receive it not, the vain mind desponds, for it has not learned to trust in itself.

49. It is difficult to form a comparative estimate of the injurious effects of pride and vanity. When the soil is good, both may produce good fruit; perhaps, however, pride presents the most effectual obstacles to improvement, and vanity tends most to render that improvement ineffectual. In the early periods of life the good opinion of others is the highest stimulus which the mind can receive, and, well directed, it has its full effect in prompting to the attainment of moral and mental excellence. The circle at first is narrow: the few friends on whom we depend for the various comforts and enjoyments of life, are those, whose good opinion forms our first object. If these are, fortunately for us, correct in their appreciation of worth, their good opinion is the source of future excellence, it prompts to the formation of the most valuable habits, and lays the foundation for that desire of honour which afterwards raises the mind to him whose approbation is happiness. If they make their approbation depend upon right conduct, and do not lavish their praise or their censure, but give it only where justly estimated, praise or censure is due, the result is valuable; if they teach to value the praise of the wise and the good only, vanity will in time be brought within proper limits; but they do not do all if they do not teach that the pleasure which they at present receive from their friends, is afterwards to be chiefly sought for in that of their best friend, that his approbation is to be made the criterion of excellence, and that by this they must appreciate the worth of all other sources of honour. If indiscriminate vanity be not thus checked, the mind which seeks the good opinion of others will fall into the opinions and practices of others; unsteadiness of principle and of conduct must be expected, for that on which they are founded is variable as the wind. The stimulus of praise becomes necessary to happiness; and the mind is incapable of exertion where that praise is not to be obtained; is incapable of acting in opposition to the opinion of those whose censures it deems the worst of evils, whose praise it regards as the chief of goods.—The excessive desire of the good opinion even of the wise and good, is injurious to the mind. It enervates its powers of action, it renders it fickle and inconstant: it prevents from efforts leading to high utility, where those efforts may be misinterpreted: it checks the attention which should be paid to superior honour; and it prevents that ardent desire for the highest approbation which should be made, as far as possible, the primary object of pursuit.

50. The virtue of humility is the most difficult to acquire of all the train, yet it is this which gives the true grace to the character. It is the characteristic of christianity, and it is in this respect that the christian so far excels the stoical system of morality: the whole structure of the latter was laid upon the foundation of human pride, and though frequently captivating to the imagination, which loves to view the elevated mind, yet it often affords a poor shelter to the children of humanity. Humility does not direct us to estimate ourselves lower than impartiality requires; but it is seldom that we need fear wandering into this extreme, except where it arises from that self diffidence, which distrusts merely because vanity has not yet lent its support. This excess of diffidence is not unfrequently the cause of vanity; for the mind then feels the more eager desire to be well in the estimation of others, and, when their good opinion is obtained, fastens

it with too great pleasure. Still however the frequent mortifications it meets with tends to lower it in its own estimation, unless by degrees it learns to set a value upon its own requisition, independently of the captious applause of others; and then it deviates into the opposite extreme of self-sufficiency and pride. Here a strong mind, not under religious culture, will rest; a weak one will probably be again driven to that support on which it originally rested its self-approbation. If it do not return to its former state, the attentions which vanity received as a favour, pride claims as its right: and in both cases endless inquietude, envy, and resentment, are the almost necessary attendants.

51. The workings of vanity ought not to be viewed with too suspicious an eye in the early stages of intellectual and moral culture. Self-diffidence is almost necessary for that culture, and vanity we have seen is frequently the offspring of self-diffidence. Care however should be taken to prevent the love of praise from becoming a necessary stimulus to exertion. The stimulus should be lessened by degrees: and if done gradually, the habit which it was intended to generate will be formed, and the exercise of it continued, without this stimulus.—Praise is probably employed in education more than is desirable, because more than is necessary; perhaps the simple expressions of sympathy in successful exertions would answer every purpose. The employment of them may however be varied by circumstances; but it should always be kept in view, that praise should be little employed in the culture of moral worth; to that, approbation should be given indirectly, and when bestowed upon intellectual acquirements, it should be distinctly seen that these are not held in the same rank with the performance of duty. The young should frequently be led, if self-diffidence do not make this a bar to exertion, to contemplate those who have made greater attainments than themselves, and seldom to refer to those who are below them; in this, however, such cases should be adduced as will prevent, or rather avoid, the excitement of envy; and where emulation gives birth to envy this should be carefully avoided. But above all, they should be taught to be discriminate in their desire of approbation, and be led by degrees to seek for that approbation, which alone is certain, and which alone is independently valuable. The eager desire of the praise of men debases the motives, weakens the mental powers, and produces corroding inquietude; the ardent pursuit of the former will supply motives to action continually increasing in purity, will strengthen the mind for valuable exertion, and prepare it for permanent happiness.

Cultivation of Humility.

52. In order to cultivate the tender plant of humility, we must clear away the high ideas we have of our own excellencies. All thoughts which please are apt to recur frequently, and their contraries to be kept out of sight; hence by dwelling upon these excellencies, they will be magnified, by keeping our imperfections out of view they are diminished; and the same causes too frequently lead to keep in view the defects of others, and neglect the consideration of their excellencies; and thus pride, that is too high an opinion of ourselves, and too low an opinion of others, must be generated. Now the only way to obtain a just opinion of ourselves is to reverse this operation, and by express acts of volition dwell upon the excellencies of others and our own defects, and to pass by with little notice the defects of others and our own excellencies.—To cultivate humility we must learn not to seek the applause of the world, but to acquiesce in the respect it pays us, however disproportioned this may be to the merit of the action under consideration. We should remember, that however beautiful the productions of nature and art which pass under our notice, it would be absurd to stay till long experience and accurate examination justified it, that they are unequalled in their kind: much less should we suppose this of those sources of honour which happen to be our lot, which are certainly magnified beyond the truth in our own eyes from the interest we take in ourselves.—Humility will further be cultivated by receiving with readiness the censures and shame which we have deserved; by acquiescing, render them where we think we have not deserved them; and in this last case always to suspect our own judgment.—The frequent recollection that all our valued qualities proceed from God; that we have nothing which we did not receive from him; and that there could be no reason in ourselves why he should select us to perform the particular part he hath assigned us; and the application of this important truth to the real occurrences of our lives must greatly accelerate our progress to humility and self-annihilation.

IV. ESTIMATE OF THE PLEASURES OF SELF-INTEREST.

(PHILOSOPHY, *mental*, § 79, 84.)

53. We ought not primarily to pursue the means of obtaining the pleasures of sensation, imagination, or ambition, because these pleasures themselves, from what we have already seen, ought not to be made a primary object of pursuit. The means borrow all their value from the end, by association; and if the original value of the end be not sufficient to justify our making them our primary object, the borrowed value of the means cannot.

54. Gross self-interest, or the treasuring up of the means of happiness from these sources of sensation, imagination, and ambition, bears a very near relation to ambition. Those who desire great degrees of riches, power, learning, &c. desire also that their acquisition should be known to the world: to be thought happy often constitutes a stronger motive for action than to be happy. The reason therefore which excludes ambition as a primary pursuit excludes self-interest also. Gross self-interest has a manifest tendency to deprive us of the pleasures of sympathy, and to expose to its pains. Rapaciousness extinguishes all sparks of good will and generosity, and produces endless resentments and jealousies. And indeed a great part of the contentions and mutual injuries which we see in the world, arise because either one or both of the contending parties desire more than an equitable share of the means of happiness.—Besides, gross self-interest has a most painful and peculiar tendency, to increase itself by the constant recurrence and consequent augmentation of the ideas and desires that relate to self, and the exclusion of those which relate to others.—This inconsistency of gross self-interest with sympathy, would be an argument against it barely upon the supposition that sympathy was one necessary part of our nature, which ought to have an equal share with sensation, imagination, and ambition: but as it now begins to appear from the exclusion of those as primary objects, that more than an equal share is due to sympathy, the opposition between them is a strong argument against self-interest.—There is in like manner an evident opposition between gross self-interest and the pleasures of theopathy and the moral sense; hence if these be admitted as essential parts of our nature, and especially when it is shewn that they ought to be made primary objects of pursuit, an insuperable objection arises against our making the pleasures of self-interest our primary objects.—Gross self-interest, when indulged, destroys many of the pleasures of sensation, and most of those of imagination and ambition; that is, many of those pleasures from which it takes its rise. This is peculiarly true and evident in the love of money, and it holds in a considerable degree with respect to other selfish pursuits. It must therefore destroy itself in part, as well as the pleasures of sympathy, theopathy, and the moral sense, with the refined self-interest founded upon them. And thus it happens that in very avaricious persons, nothing remains but a sensual selfishness, and an uneasy hankering after money, which is a more imperfect state than that in which they were at their first setting out in infancy.—Men, in treasuring up the means of happiness without limit, seem to go upon the supposition that their capacity for enjoying particular species of happiness is infinite, and consequently that the power of enjoyment depends upon the stock of means which they amass. But our capacity for enjoying happiness is confined and fluctuating; and there are many periods during which no object, however grateful to others, can afford any pleasure, owing to the diseased state of our minds or of our bodies.—Further, it is evident in part, that self-interested men are not more happy than others, whatever means of happiness they may possess. Experience appears to confirm the reasoning already adduced, but it certainly confirms this conclusion. Those who are continually aiming to treasure up the means of happiness, are in general remarkably miserable. The covetous man subjects himself to hardship, care, fear, ridicule, and contempt, and thus undergoes greater evils than what fall to the share of mankind upon an average.

55. Some degrees of refined self-interest is the necessary consequence of the power of receiving the pleasures of sympathy and theopathy. He who has had a sufficient experience of the pleasures of friendship, generosity, devotion, and self-approbation, cannot avoid the desire to have a return of them, when he is not under the particular influence of any one of them, merely on account of the pleasure which they have afforded. And if he have not advanced into very considerable purity of motives, will seek to excite those pleasures by treasuring up the means of them, and to keep

himself in a disposition to use them, not from any particularly vivid love of his neighbour, or of God, or from a sense of duty, but entirely from the view of private happiness.—Refined self-interest is neither so common nor so conspicuous, in real life, as the gross self-interest. It rises late, and is never in any great magnitude in the bulk of mankind, though the want of the previous pleasures of sympathy, religion, and the moral sense, and in some it scarcely prevails at all; whereas gross self-interest rises early in infancy, and arrives at a considerable magnitude before adult age.

56. The objections which lie against making the pursuit of refined self-interest our ultimate object, though less obvious, do not appear less weighty than those which lie against gross self-interest.—In the first place, the mind which has so far advanced towards perfection, as to make the means of obtaining the refined pleasures of religion and virtue the primary object, will be more likely, finally, to stop at this point than he who was guided by gross self-interest. There is less the appearance of deficiency, and less opposition between it and the claims of benevolence and piety; and as it leads to the performance of laudable actions, the conscience is too apt to give approbation where, if all that influenced the mind were brought into full view, nothing but self would be seen. Hence there is little inducement to refine the motives, and purify them from their baser alloy; and making self continually the motive, checks the natural progress of the affections to complete disinterestedness.

57. To act with a direct view to the pleasures of benevolence and piety, seems to carry with it a degree of selfishness little superior to that of the refined sensualist, who chooses from among the objects of his degraded taste such only as will give the least alloyed pleasures, and those of the most continued duration. It differs from his selfishness, in producing to society more valuable effects; but from what has been stated respecting the progress of the affections in *mental* PHILOSOPHY, it appears that it is very considerably below that state in which the affection is perfect: and we have already seen that it stops its progress towards that perfection. It may fairly be admitted in the commencement of a virtuous course as a step towards improvement; but if the mind be suffered to rest here, we cannot esteem its progress great.—In addition to these objections, some very forcible ones will appear among those which lie against acting with an explicit view to our greatest happiness on the whole, making even the highest least debasing, because least specific kind of self-interest, our ground of action.

58. Rational self-interest is certainly to be put upon a very different footing from the gross and refined; agreeably to which the scriptures promise general hopes and fears, and especially those of a future state, and inculcate them as good and proper motives: and they may, therefore, certainly be considered as auxiliary in our moral progress. But Christianity holds out still more refined motives, distinct from hope and fear,—the love of God and our neighbour, the law of our minds, &c. that is the motives of sympathy, theopathy, and the moral sense. Rational self-interest will lead to the formation of these, and to the destruction of the impure motives to action; and precisely as far as it does this, it may be reckoned a virtue. When it tends to cherish the impure motives, or simply to obstruct the growth of the pure motives, then it must be considered as a vice. That we ought not to rest satisfied with that state in the moral progress, in which an explicit and direct view to the greatest general happiness or misery is made the primary motive to action, may be argued from the consideration, that a constant attention even to these most general hopes and fears would extinguish, by degrees, our love of God and our neighbour, and this especially by augmenting the ideas and desires which centre immediately in self to an undue height.—While our own happiness, even the most refined and general, is the explicit motive, benevolence and piety will never acquire that disinterestedness which will prompt to their respective course of conduct, without any exterior stimulus, simply by the impulse of the affection.—Rational self-interest will at times be present to the mind even of those who have advanced highest in the scale of present excellence; and in the early stages of the moral progress, may be called in as a most careful auxiliary, and important support; but even this must be made subordinate to the cultivation of those affections, which are only perfect as they approach disinterestedness.

59. We shall conclude this head in the words of Dr. Reid, with a few alterations.—Though a steady pursuit of our own real good may, in an enlightened mind, produce a degree of virtue which is entitled to some

approbation, yet it can never, while the mind rests with this explicit regard to self, produce the noblest kind of virtue which claims our highest love and esteem.—We account him a wise man who is wise for himself; and if he prosecute his end through difficulties and temptations, his character is far superior to that of the man who having the same end in view, is continually starting out of the road from an attachment to his appetites and passions, and doing every day what he knows he shall heartily repent. —Yet, after all, this wise man whose thoughts and cares are all centered ultimately in himself, who indulges even his social and divine affections only with a view to his own good, is not the man whom we cordially esteem, nor who possesses the noble elevation of mind which commands our admiration. Our cordial esteem and admiration are due, are given, only to him whose soul is not contracted within itself, but embraces a more extensive object; who loves religion, not for her dowry only, but for her own sake; whose benevolence is not selfish, but generous and disinterested; who, forgetful of himself, has the common good at heart not as a means only, but as an end; who abhors what God and conscience condemn, however attractive its appearance; who chooses, without hesitation, what God and conscience approve, though surrounded with ten-fold dangers.— Such a man we esteem the perfect man, compared with whom, he who has no other aim than good to himself, is a mean and despicable character.—To serve God and be useful to mankind without any concern about our own good and happiness, is probably beyond the pitch of human nature. But to serve God and to be useful to men, merely to obtain good to ourselves, or to avoid ill, is imperfect service, and not of that liberal nature which true devotion and real virtue require.

60. Though we might be apt to think, that he has the best chance for happiness who has no other end of his deliberate actions but his own good, yet a little consideration will satisfy us of the contrary. A concern for our own good is not a principle that of itself gives any enjoyment; on the contrary, it is apt to fill the mind with fear, and care, and anxiety. And these concomitants of this principle often give pain and uneasiness, which counterbalance the good they have in view. We may compare, in point of present happiness, two imaginary characters, the first, of the man who has no other ultimate end of his deliberate actions than his own good, and who has no regard to religion and duty but as means to that end: the second, of the man who is not indifferent with regard to his own good, but has another ultimate end, (perfectly consistent with it) a disinterested love of goodness for its own sake, or a regard to duty as an end. Comparing these two characters in point of happiness, that we may give all possible advantage to the selfish principle, we shall suppose the man who is actuated solely by it, to be so far enlightened as to see it his interest to live soberly, righteously, and piously in the world, and that he follows the same course of conduct from the motive of his own good only, which the other does, in a great measure, or in some measure, from a sense of duty. The one labours for hire, without any love to the work; the other loves the work, and thinks it the most noble and the most honourable he can be employed in. In the first it is mortification and self-denial to which he submits only through necessity; to the other it is victory and triumph in the most honourable warfare.—It ought further to be considered, that though wise men have concluded that virtue is the only road to happiness, and the commands of a benevolent Creator necessarily lead us to consider it as such; yet he who follows it only as a means to an end, and who obeys God only for the sake of the rewards he has attached to obedience, would, in all probability, be continually wandering from the direct path, and seeking for happiness, where it was not to be found.—The road to duty is so plain, that the man who seeks it with an upright heart cannot greatly wander from it; but the road to happiness, (except where that confidence in the Supreme Being is formed, which supposes the pious affections to have become disinterested) would be found dark and intricate, full of thorns and dangers, and therefore not to be trodden without fear, and care, and perplexity.—The happy man, therefore, is not he whose happiness is his only care; but he who with perfect resignation leaves the care of his happiness to his Maker, while he pursues with ardour the road of his duty. This gives an elevation to his mind which is real happiness; instead of care, and fear, and anxiety, and disappointment, it brings peace and joy. It gives a relish to every good we enjoy; it smoothes the brow of distress, calms the perturbed mind, and makes the pillow of suffering and of death the rest of happiness.

V. ESTIMATE OF THE PLEASURES OF SYMPATHY.

(PHILOSOPHY, *mental*, § 85—88).

61. We have now proceeded through and examined all those sources of happiness which do not coincide with what we established as the standard of comparison, the greatest ultimate happiness. We have seen, that if any of them be made the primary object of pursuit, happiness cannot be obtained; and that the greatest degrees of these pleasures are to be obtained, not by making them our primary object, but submitting ourselves to the guidance of benevolence and piety. We might hence alone be inclined to consider the inference a just one, that the affections of benevolence and piety, and those actions to which they prompt, should be made by us our primary object. We shall feel our ground more sure when we enter into the positive arguments for these premises; and we now proceed to ascertain what rank the benevolent affections should have in our rule of life.—And here it is to be laid down as a principle, that the cultivation of these affections should be made a primary object of pursuit for the following reasons.

62. Benevolence improves the inferior pleasures, by limiting and regulating them, as we have already seen in the course of our former investigations.—Again the pleasures of benevolence unite and coincide with those of piety and the moral sense. That benevolence unites with piety is obvious; for by the love of the good we are led to love the source of goodness; and back again from the love of God to the love of all that he has made. The pleasures of benevolence are one principal source of the moral sense, and the moral sense in its turn improves and enforces them entirely.

63. The pleasures of benevolence are unlimited in their extent.—In order to shew that the pleasures of sensation did not deserve our primary attention, an extreme case was taken of a person who actually made them his primary object: in the same way suppose a person to take all opportunities of gratifying his benevolent desires, making it his study, pleasure, and constant employment either to promote happiness, or to lessen misery. Now it is very obvious, that he would have a very large field for exercise, no less than the whole round of domestic and social relations. And if his benevolence were pure, and regulated by the dictates of piety and the conscience, he might in general expect success. And from the experience of those who have made the trial, it does not appear that the relish for its pleasures languishes, as in other cases, but gains strength by gratification; and they continue to please in reflection. The reason of this is obvious from the law of association; for since they are in general attended with success, and are consistent with and productive of the several inferior pleasures in their due degree, and are also further increased by the moral and religious pleasures, they receive fresh addition upon every gratification, and therefore increase perpetually when the affections are cultivated as they ought to be.

64. The pleasures of benevolence are self-consistent.—All may share them without diminishing their mutual happiness. Harmony and mutual co-operation prevail among the benevolent; and benevolent actions have a tendency to excite correspondent actions indefinitely.—By degrees, when benevolence has arrived at its due height, all the sensibilities of the individual for himself will be more or less transferred upon others, by his benevolence and compassion for them. And in like manner, when our moral sense is sufficiently established and improved, and we are capable of being influenced to perform what is fit and right, by the consideration that it is so, our imperfect sensibility for others tends to diminish, by being compared with it, our exorbitant attachment to ourselves; at the same time that compassion takes off our thoughts from ourselves. And thus benevolence to a single person may ultimately become equal to self-interest by this tendency of self-interest to increase benevolence, and reciprocally of benevolence to lessen self-interest, though originally self-interest was indefinitely greater than benevolence; and thus we may learn to be as much concerned for others as for ourselves, and as little concerned for ourselves as for others.—It is not often that benevolence is thus heightened: perhaps in the strictest sense it can never reach this height in the present state; but take the case where there is a decided preponderance of benevolence over every feeling which bears the character of malevolent. It is not perhaps capable of proof, but certainly has decided probability, that in the circle in which each moves, and in the circle of the race at large, happiness decidedly preponderates. If the benevolent individual, though he do not see this balance of happiness clearly, yet has some

comfortable general knowledge of it, he must be a great gainer in the whole by his benevolence, because thus he has a source of constant gratification in the perception of such a preponderance of happiness among those in whose happiness he has learned to rejoice in some measure as in his own.

65. It will confirm our belief that the cultivation of benevolence should be made a primary pursuit of life, if we recollect that its pleasures lie open to all kinds and degrees of men, since every man has it in his power to benefit others, and since we all stand in need of each others good offices. —Unlike the brute creation, we are dependent upon each other from the cradle to the grave, for life, for health, for convenience, for pleasure, for intellectual accomplishments, and are unable to subsist with comfort singly, or even in very small societies; and this may be considered as a mark of the superior excellence of man's social pleasures. All the tendencies of the events of life, ordinary and extraordinary, of the relations of life, of the various pleasures which have been enumerated, to connect us together, to connect accidental associations, and these forced upon us by the common situation of man, and his situation in society, into permanent affections, prove the same thing; so great, indeed, is this tendency, that two men without claims to the title of benevolent, can scarcely become familiarly known to each other, without conceiving some good-will, complaisance, compassion, and tenderness, for each other.—Further, we love, esteem, and assist the benevolent more than others: so that a benevolent action not only excites the receiver to a grateful return, but also the bystander to approve and reward: and benevolence receives a hundred-fold, even in this world.—"But," says the excellent Hartley, "it would be endless to pursue this. Benevolence is, indeed, the grand design and purport of human life, of this probationary state; and every circumstance of human life duly considered, must and does point to it directly or indirectly."

66. As it is now established that benevolence is a primary pursuit, it follows, that all the pleasures of malevolence are excluded, as direct obstacles to our happiness. The lower pleasures may all be made consistent with, and even subservient to, benevolence, by the limitations and power of it: but those of malevolence are quite incompatible with it. As far as malevolence is allowed, benevolence must be destroyed. —There is, however, this exception; where wishing evil to some, disposes us to be more benevolent on the whole (as in the case of what is called a just indignation against the vicious), it may somewhat aid the moral progress in the lower stages of benevolence. But it is exceedingly dangerous to encourage such a disposition of mind, by satire, invective, or dispute, however unworthy the opponent may be; for fostered, it will soon wear the features of ill-will, will soon totally become rank malevolence.

67. We must not only forego the pleasures of malevolence, but patiently and resolutely endure the pains of benevolence, particularly those of compassion. But we shall not be losers on either of these accounts. The pleasures of the moral sense, which result from these virtues, will, in the first case, compensate for what we forego; in the last, overbalance what we endure. Besides, mercy and forgiveness are in themselves pleasures, and in the event productive of many others; and compassion generally leads us to such conduct as makes the afflicted to rejoice, and increases our disposition to rejoice with them.

68. As benevolence is thus supported by many direct arguments, there are many similar and apposite arguments to prove that malevolence is the bane of human happiness; that it occasions misery to the agent as well as the sufferer; that it is indefinitely inconsistent with itself, and with the course of nature; and that, consequently, it is impossible that it should subsist for ever. Now all these become so many indirect arguments for benevolence, and urge us to make the cultivation and exercise of it the supreme pleasure and end of our lives.— In order to make this appear more fully, we have only to take a survey of human life, the reverse of what we have already attended to. Injuries are increased by mutual injuries, till at last mutual sufferings oblige both parties to desist: the increase and constitution of human nature give numberless admonitions to forbear; and the hand of every man, and the power of every thing, is against the malevolent. So that if we suppose a number of beings to be purely malevolent, and consequently to have an indefinite number of enemies, they would first cease from their enmity on account of their mutual sufferings, and become purely selfish, each being his own sole friend and protector; and afterwards, by mutual good offices endear themselves to each other; so that at last each of them

would have an indefinite number of friends, and thus would be indefinitely happy.—This is, in part, mere supposition; but its obvious correspondence with what we see and feel in real life, is a strong argument both of the infinite goodness of God, and consequently of the tendency of all beings to unlimited happiness through benevolence. For the beings whom we have supposed to set out with pure malevolence, could no more rest at pure selfishness, or any other intermediate point, than they could at pure malevolence.—And thus the arguments which exclude pure malevolence, necessarily infer that pure unlimited benevolence should be the ultimate object of man.

Culture of Benevolence.

69. In order to augment the benevolent, and suppress the malevolent affections, we should diligently practise all such acts of friendship, generosity, and compassion as our abilities of any kind extend to; and rigorously refrain from all sallies of anger, resentment, envy, jealousy, &c. For though our affections are not directly and immediately subject to the voluntary power, yet our actions are; and, consequently, through them, our affections. He that at first practises acts of benevolence by constraint, and continues to practise them, will at last have associated with them such a variety of pleasures, as to transfer a great instantaneous pleasure upon them, and produce in himself the affections from which they naturally flow. In the like manner, if we abstain from malevolent actions and expressions, we shall dry up the ill passions which are the sources of them.

70. With the same objects in view, it will be of great use, frequently, to dwell upon the great pleasures and rewards attending on benevolence; and also upon the many evils, present and future, to which the contrary disposition exposes us. For thus we shall likewise transfer pleasure and pain by association upon these dispositions respectively; and rational self-interest will be made to produce pure benevolence, and to extinguish all kinds and degrees of malevolence.

71. Frequent and fervent prayer for others, friends, benefactors, strangers, and enemies, has a very great and decided tendency to augment benevolence, and to extinguish malevolence. All exertions of our affections cherish them; and those made under the more immediate sense of the divine attributes, have an extraordinary efficacy, in this respect, by mixing the love, awe, and other exalted emotions of the mind attending our addresses to God, with our affections towards man, so as to improve and purify them. Petitions for the increase of our benevolence, and the suppression of our malevolence, have the same tendency.—Again, all meditations upon the attributes of God, and particularly upon his infinite benevolence towards all his creatures, have a strong tendency to refine and augment our benevolent affections.—And, lastly, the frequent consideration of our own unworthiness, our entire dependence upon God, &c. raises in us compassion for others, as well as concern and earnest desires and prayers for ourselves. And compassion, in this imperfect probationary state, is an essential and principal part of our benevolent affections.

Rules for the Conduct of Men towards each other in Society.

PRACTICAL BENEVOLENCE.

72. Having now established the position, that benevolence should be a primary pursuit of men, it follows that we should aim to direct every action, so as to produce the greatest happiness and the least misery in our power. This is the rule of conduct towards our fellow creatures, which universal, unlimited benevolence inculcates.—But the application of this rule in real life, is attended with considerable difficulties and perplexities. It is impossible for the most sagacious and experienced to make any very accurate estimate of the future consequences of particular actions, so as, in all the variety of circumstances which occur, to determine justly which action would contribute most to augment happiness and lessen misery. Instead, therefore, of this very general rule, we must substitute others less extensive, and subordinate to it, admitting of a more commodious application. Whatever rules are laid down for this purpose, it is obvious, that their coincidence must add strength to each; and that when they differ, or are apparently opposite to each other, this difference or opposition must moderate or restrain their application. On the whole, however, the general result will prove the best direction for promoting the happiness, and lessening the misery, of others.

73. Hartley lays down the following ten subordinate rules: "1. That we obey the Scripture precepts, in the natural, obvious

meaning of them.—2. That we should pay great regard to the dictates of our own moral sense, and to those of others.—3. That in deliberate actions we should weigh the probable consequences on each side.—4. That we are not to be guided implicitly by the mere impulse of compassion and good-will; yet that great regard should be paid to them in our conduct.—5. That we should place ourselves in the situation of the persons concerned.—6. That persons in the near relations of life, benefactors, dependants, and enemies, seem to have, in most cases, a prior claim to strangers.—7. That benevolent and religious persons have, all other things being equal, a prior claim to the rest of mankind.—8. That we should contribute, as far as lies in our power, to the moral and religious improvement of others.—9. That we ought to pay the strictest regard to truth, both in our affirmations and in our promises.—10. That we ought to obey the civil magistrate and the laws of the community."—These rules we think truly unexceptionable; and we shall follow the order of Hartley, enlarging on some of them as we proceed. It appears, however, to be desirable, that we first enter a little into the consideration of the necessity of our acting upon general rules of conduct.

74. To show that general rules of conduct are necessary in the present state of human nature, it is simply requisite to answer the question, What would be the state of things without them? We should then be under the necessity of calculating in every case that comes before us, on what side the good or evil attending certain actions preponderates. In fact, our lives would be a series of thought, instead of what they were designed to be, a series of action. A total stop would be put to the business of life, and instead of regularity and consistency in a person's conduct, we must expect to find nothing but a series of actions, constantly proceeding from no steady principle, and marked with all the features of inconsistency.—But further, we are led to the same conclusion, when we consider our ignorance of futurity, and the little time and leisure possessed by the generality of men for the investigation of the consequences of their actions. We not unfrequently are unable precisely to trace even those consequences which are immediate and apparent, still less those which arise silently and gradually in the lapse of time. The consequences of our actions may last when the agents have long ceased to exist as children of mortality. Our actions may influence others; our deviations may produce more extensive deviations, of which we have no knowledge. Perhaps there is scarcely an important action in our lives, the consequences of which are confined to ourselves, or even to our own sphere of observation.—Besides, if we were unable to lay down general rules for conduct, and were obliged to decide upon each action as it occurred, it is scarcely possible that we should avoid the influence of heated feeling; and seldom should we possess that abstraction of mind, which would enable us to leave the present out of consideration, and view with calmness and impartiality the tenderness of our actions. Innumerable are the cases in which interest or passion paint in vivid colours the course to which they prompt, and throw into the back ground, and render almost imperceptible, the dangers which should induce us steadily and perseveringly to avoid it: hence, we may lay it down as indispensably necessary, that there should be general rules for conduct, and consequently a deviation from a general rule must of itself be an evil.

75. Yet there are cases in which the general rule seems to fail of application; in which the immediate consequences are such as benevolence, equally with self-interest, seems to reject. In such cases our inquiry should be, what would be the consequence if the conduct became general, which, in my individual case, seems to be so favourable to happiness, social or private. And if we have reason to believe that it would be injurious, our belief, in the beneficial tendency of the individual action, should be considered as less founded; we should perhaps in all cases, certainly in most, unhesitatingly sacrifice much private advantage, and even the apparent good of others to consistency in our adherence to what on the whole must be best. We may indeed think that the consequences which would arise from the general adoption of our individual conduct, ought not to be attributed in any way to us; but we should recollect that if we once break down the barrier, however small the breach, the advantage gained by the enemy is evident. In fact, when once we remove the limits which reason and revelation fix, we usurp to ourselves the privilege of the Almighty, and cannot fail to prove our own weakness.—It is on this ground, and with great justice, that Paley considers crimes as deriv-

ing their criminality, not so much from the consequences of the individual action, as from the consequences which would result from such actions becoming general. Thus the man, who by the forgery of a one pound note, may probably render no individual injury worth estimating in the punishment of a fellow creature; and another, who by the forgery of a large bill, without direct intention, ruins an individual family, are both equally culpable in the eye of reason, and perhaps as far as punishment is beneficial to others, he who has forged the one pound note deserves greater severity of punishment, because the means of committing his depredation on society are much more practicable than in the other case. But in both it is not the individual injury sustained that is to regulate the proportion of demerit, but the consequences which would follow the total destruction of commercial intercourse and of mutual confidence.

76. By the application of this important principle, much of that obscurity is dissipated, which seems to involve some questions on morals which are intimately connected with the well-being of society. Many of those violations of veracity, for instance, which even benevolence seems to authorise, will appear to be direct deviations from the soundest principles of morality, and consequently to be unauthorised by benevolence, when viewed in their fair extent, however much the immediate consequences may seem to demand them.—There is, however, one restriction to this rule which seems to be necessary in order to enable us fully to submit to its influence. It is whether the probability of our conduct being generally adopted, be sufficient to counterbalance the advantages or disadvantages which would arise if such general adoption took place.—Let us apply it to the case I have already adduced of the violation of truth. Now it is very obvious that in most cases in which there is any strong tendency to such violation, it arises from the desire to remove or avoid some ill attending our adherence. Hence the temptation to repetition, either by ourselves or others, will always be sufficiently powerful, if no counterbalancing considerations prevented to induce us to deviate from truth, and therefore the probability of our conduct becoming general, is indefinitely great, and consequently indefinitely strengthens the reasons we draw against such deviations from their ill effects if they become general.—On the other hand, it is obvious, that if all who could afford it gave to the poor to the extent of their ability, the sources of industry would be dried up, and society would immediately fall into such confusion, that if the ideas of punishment were not very enlightened, alms-giving might be deemed a capital crime. Hence we might argue from the general principle already laid down, that we ought not to give at all; and we think Paley defective in appearance at least for having furnished no clue to a solution of the difficulty. It is immediately solved by the restrictive rule which has been laid down; What is the probability that alms-giving will become general, or even so general as to produce the feared effects in a small degree? If this be very small, we have nothing more to do than to consider which is the best direction for our superfluities, and give with the certainty that our conduct will not become so universal as to render it injurious instead of beneficial.—We now proceed, following Hartley as our outline, to consider those rules of conduct by which we may safely guide ourselves through the intricacies of human life.

77. The first rule is that we obey the Scripture precepts in the natural obvious meaning of them.—The Scripture precepts are indeed in themselves the rule of life. There is, however, the same kind of difficulty in applying them accurately to particular cases, as in applying the above-mentioned most general rule, by means of an estimate of the consequences of actions. It is impossible in many particular cases to determine precisely the connection of the action with the precept. However, unless it would obviously lead a person to act in opposition to some or other of the following rules, it is the safest way, in the particular circumstances of real life, to recollect the Scripture precepts, and follow them in their first and most obvious sense.

78. Secondly, great regard must be had both to the dictates of our own moral sense, and that of others. It is remarked, with great justice, by Dr. Aikin, that, in a mind whose moral powers have been cultivated, second thoughts are seldom the best. The first are the impulse of well-regulated feeling, and are produced instantaneously without attention to all the petty suggestions of self, which crowd themselves in various ways into our minds, and by leading to doubt, and then aided by inclination to disobey, prevent the efficacy of the conscience, and throw a mist over the before clear directions of duty.—With respect to the

moral sense of others, two motives should induce us to regard its dictates. The one is purely benevolent: we ought not to throw any impediment in the way of the duty of others: the other is, that prudence and humility direct, that we use the experience and the feelings produced by great moral culture, as guides of our own conduct.

79. Thirdly, it is very proper that, in all deliberate actions, we weigh, as well as we can, the probable consequences on each side, and suffer the balance to have some influence in all cases, and particularly where the other rules do not interfere, or where they fail of application. But they are generally the dictates of self-interest and pride, to be determined by our own judgments as to consequence, in opposition to rules of duty.

80. Fourthly. The impulse of the more instantaneous emotions of good-will and compassion will not always furnish a sufficient guide; at the same time they ought to have great regard paid to them, lest we contract a philosophic hardness of heart by pretending to act upon higher and more extensively benevolent views than vulgar minds, or the more feeling sex, &c. Some, however, carry this much too far on the other side, and encourage many public mischiefs through a false, misguided tenderness to criminals, persons in distress through present vice, &c. When feeling is thus made the guide of conduct, he who can best play upon the sympathy, and best decorate his tale of woe, will meet with a reward for his ingenuity, due only to the modest merit which shrinks from the public view, or at least obtrudes not itself upon our notice. The injury done to society at large by this ill-directed compassion, so generally prevalent because it gratifies without trouble, is very great indeed; and while we have it in our power to cultivate compassion and sympathy, by the view and the relief of real misery and suffering worth, the desire of such cultivation is scarcely sufficient to exculpate us, when our minds have acquired some degree of comprehension, from the charge of preferring a selfish, indolent gratification to the good of others. To use the words of the elegant Stewart, "the dictates of reason and conscience inform us, in language which it is impossible to mistake, that it is sometimes a duty to check the most amiable and pleasing emotions of the heart; to withdraw, for example, from the sight of those distresses which stronger claims forbid us to relieve, and to deny ourselves that exquisite luxury which arises from the exercise of humanity."

81. Fifthly, the rule of placing ourselves in the several situations of the persons concerned, and inquiring what we should then expect, is of excellent use for directing, inforcing, and restraining our actions, and for producing in us a steady, constant sense of what is fit and equitable.—This rule is so comprehensive, that it may be called the sum and substance of Christian morality. It has been objected by some, that it teaches nothing, for it shows not what justice is; and that it is an improper rule, for we ought not to do to others what we should wish them to do to us, but what we may justly expect them to do to us. But this is no real objection. The object of the rule most probably is, to serve as a criterion of duty which should counteract the impressions of self. We never need fear lest we should carry our imaginary substitution to too great a length, and think of what passion or interest might lead us to expect: when not under the influence of passion or interest, it is more than probable that we shall be guided sufficiently accurately. Our only danger is, lest we should not go far enough, that we should admit of this principle, which, if circumstances had been real, ought to have had no place.—This rule of duty, says Dr. Reid, comprehends every rule of justice without exception. It comprehends all the relative duties, arising either from the more permanent relations of parent and child, of master and servant, of magistrate and subject, of husband and wife, or from the more transient relations of rich and poor, of buyer and seller, of debtor and creditor, of benefactor and beneficiary, of friend and enemy. It comprehends every duty of charity and humanity, and even of courtesy and good manners.—He who acts invariably by this rule, will never deviate from the principle of his duty but from an error of his judgment.

82. The word justice (says Mr. Stewart, in his "Outlines"), in its most extensive signification, denotes that disposition which leads us, where our own temper, or passions, or interest, are concerned, to determine and to act without being biassed by partial considerations. In order to free our minds from the influence of these, experience teaches us either to recollect the judgments we have formerly passed in similar circumstances, on the conduct of others;

or to state cases to ourselves in which we, and all our personal concerns, are entirely left out of the question.—Justice operates, first, in restraining the partialities of the temper and of the passions; and, secondly, in restraining the partialities of selfishness, where a competition takes place between our interests and those of other men. These two modifications of justice may be distinguished from each other, by calling the first candour, the second integrity, or honesty. The Professor's remarks on the subject of candour are very valuable and important; and we deem no apology necessary for laying them before our readers. This disposition, he observes, may be considered in three points of view; as it is displayed in judging of the talents of others; in judging of their intentions; and in controversy.

83. The difficulty of estimating candidly the talents of other men arises, in a great measure, from the tendency of emulation, to degenerate into envy. Notwithstanding the reality of the theoretical distinction between these dispositions of mind, it is certain that in practice nothing is more arduous than to realise it completely; and to check that self-partiality, which, while it leads us to dwell on our own personal advantages, and to magnify them in our own estimation, prevents us either from attending sufficiently to the merits of others, or from viewing them in the most favourable light. Of all this a good man will soon be satisfied from his own experience; and he will endeavour to guard against it as far he is able, by judging of the pretensions of a rival, or even of an enemy, as he would have done if there had been no interference between his claims and theirs. In other words, he will endeavour to do justice to their merits, and to bring himself, if possible, to love and to honour that genius and ability which have eclipsed his own.—Nor will he retire in disgust from the race, because he has been outstripped by others, but will redouble all his exertions in the service of mankind; recollecting, that if nature has been more partial to others than to him in her intellectual gifts, she has left open to all the theatre of virtue; where the merits of individuals are determined, not by their actual attainments, but by the use and improvement they make of those advantages which their situation has afforded them.

84. Candour in judging of the intentions of others is a disposition of still greater importance.—It is highly probable that there is much less vice, or criminal intention, in the world, than is commonly imagined; and that the greater part of the disputes among mankind arise from mutual mistake, or misapprehension. Every man must recollect many instances in which his motives have been grossly misapprehended by the world; and it is reasonable for him to allow that the case may have been the same with other men. It is but an instance then of that justice we owe to others, to make the most candid allowances for their apparent deviation, and to give every action the most favourable construction it can possibly admit of.—Such a temper, while it renders a man respectable and amiable in society, contributes perhaps more than any other circumstance to his private happiness.

85. Candour, in controversy, implies a strong sense of justice united to a sincere and disinterested love of truth. It is a disposition of mind so difficult to preserve, and so rarely to be met with, that the most useful rule, perhaps, to be given with respect to it, is to avoid the occasions of dispute and opposition.—A love of controversy indicates not only an overweening vanity, and a disregard for truth, but in general, perhaps always, it indicates a mediocrity of genius; for it arises from those feelings of envy and jealousy which provoke little minds to deprecate the merit of useful discoveries. He who is conscious of his own inventive powers, and whose great object is to add to the stock of human knowledge, will reject unwillingly any plausible doctrine till after the most severe examination; and will separate with patience and temper the truth it contains from the errors that are blended with them. No opinion can be more groundless than that a captious and disputatious temper is a mark of acuteness. On the contrary, a sound and manly understanding is, in no instance, more strongly displayed, than in a quick perception of important truth when imperfectly stated and blended with error: a perception which may not be sufficient to satisfy the judgment completely at the time, or at least to enable it to obviate the difficulties of others; but which is sufficient to prevent it from a hasty rejection of the whole from the obvious defects of some of the parts.—The effects of controversy on the temper, although abundantly sensible even in the solitude of the closet, are more peculiarly adverse to the discovery of truth in those disputes which occur in conversation; and which seldom answer any purpose, but

to rivet the disputants more firmly in their errors. In consequence, indeed, of such disputes, the intellectual powers may be sharpened, and original hints may be suggested; but few instances are to be found in which they do not mislead the disputants to a still greater distance from truth than before, and render their minds still more inaccessible to conviction.

86. Sixthly, persons in the near relations of life, benefactors, dependents, and enemies, seem to have in most cases a prior claim to strangers. General benevolence arises from the cultivation of the particular sources of it. The root must therefore be cherished before we can expect the branches to flourish, and the fruit to arrive at its perfection.—Attention to this rule leads us to avoid all those opinions, which attempt to found universal upon the ruin of confined benevolence: however specious they may appear they are false, because they counteract the moral improvement of man by checking it at its origin. We particularly refer to those which Godwin has advanced in his work on Political Justice. —His most general principle is, that every individual exertion should be directed so as to produce the greatest possible sum of good to the species. Hence, that if we have the power to save the life or increase the happiness of one or two fellow creatures, we owe our exertions to him who is useful, and perhaps extensively useful to society, in preference to him who is an useless, or perhaps injurious member of society. The claims of self are excluded by the general principle. "What magic," says Godwin, "can there be in the word *my* which should change its operation?" Hence the claims of confined charities ought not to oppose the deductions from the general principle. Hence it is not our business in the direction of our benevolent exertions, to consider what is the relation in which the individual stands to us; but that in which he stands to society. Not, is he my parent, relative, friend, or benefactor; but, is he a worthy or a worthless member of society.—Godwin's errors are the more injurious, because they appear to be the errors of benevolence; they result from the inaccurate extension and application of principles which in themselves are indisputable. Whenever private interest interferes with the public good, private interest is to be sacrificed; and this, whether our own immediate good is the object, or the good of those who are intimately connected with us, by some of the natural bonds; that is, those which arise in the mind by the laws of our constitution. That the conduct dictated by confined charity is to yield to general good, cannot be disputed; but that we are in all cases to act totally independently of a regard to those confined charities, is a position which will not bear the test of experience nor of the mental constitution of man.—In the first place, benevolence never could arise in the human soul, but through their medium. Love to others is founded on feelings originally personal, then it embraces the narrow circle of our immediate friends and acquaintance, and then perhaps there is little difficulty in extending it to those who bear with us the relation of children to the great parent of mankind. But before we can form the desire to do good to all men, we must have formed the desire to do good to some men; and though the desire of doing good to some, may be of that confined nature which would lead to the promotion of their aggrandisement and happiness, at the expense of those of others, yet the confined charities form too important a part in the great system, to be on this account rejected, as not being on the whole safe guides. We may lop off the excrescences, but it would be folly to destroy the root.—But, secondly, admit the formation of the feelings of general benevolence independently of the private charities, it is obvious that without long culture and enlarged views, the general feelings cannot acquire the vividness, which, by their frequent recurrence and particularity, the more confined feelings can. Hence the removal of misery would be left to those who had thus cultivated the extensive affections, and consequently the means of removing it must be most materially diminished.—Thirdly, it would leave no rule for conduct upon which any one could act. If we are to be determined in our acts of benevolence, particularly in cases of immediate urgency, merely by the consideration of the utility of the individual to society, our lives would be a continual series of calculation, and, in general, of erroneous calculation. Who is there capable of accurately appreciating the worth of the individual? Our ideas are, in general, formed merely upon the appearances which strike our attention, and force us to observe them. The silent efficacy of example and private exertions to remove misery, and still more

to remove or prevent vice, the parent of misery, are in general known only to Him who seeth in secret. Even in cases where much is obvious, what diversity shall we find in opinion; and where the co-operation of individuals for the benefit of others is necessary, how improbable that they should have formed the same standard.

87. But admit that the cases are clear, that the person whom we are about to leave to death is, obviously and decisively, a less important member of society than he whom we attempt to save, if we violate none of those feelings which rise up in the human frame altogether independently of the will of the individual, there can be no hesitation; but suppose that our proposed conduct will violate them—let it first be considered, that they are not only necessary to the culture, nay even to the formation of individual benevolence, but to the well ordering, perhaps to the very existence, of society. Take the strongest case, suppose the filial and parental affections to be annihilated, (and it is absurd to justify and lay down as just, that conduct which, if not counteracted by the eternal laws of our frame, would lead to such annihilation, if that annihilation itself be not an object of desire), suppose these affections annihilated, and the heart shrinks from the picture. The claims of the helpless infant upon the parent would be rejected; and, if enlarged views of duty to society did not induce the parent to think that he had better remove from existence a being who would be a burden to others and himself, and who probably would not be educated so as to be wise and happy, there would arise constant discouragements which would effectually prevent those steady uniform endeavours to cultivate the mental and moral powers, which are necessary to attain the object; and if the evil did not soon eradicate itself, man, if he existed, would gradually sink to the level of the brute.—But if the parental affections existed not, neither would the filial. Here it is that the rudiments of good will are formed in the infant breast; here it is that the being who is to love all mankind begins his career of love; here is the source of that ardent disinterested benevolence which carries the individual out of himself, which leads him to forget himself and all his immediate interests, and view only the good of others. Can it be supposed that this highly cultivated benevolence is in opposition to that more confined affection from which it sprung. No, we see it modifying its direction, but never annihilating it. On the contrary, it may be justly affirmed, that the confined affections become more inwrought in the frame, as universal benevolence become more and more a ruling feature of the mind; and it must, for universal benevolence is but the sum total of all the confined affections, extended by the hand of piety.

88. We have before mentioned, that there are two considerations upon which we ought to act in cases where we are left to be guided by the views of the consequences of our actions. The first is, what would be the consequence if our conduct became general? the next, what is the probability of this extension of our conduct? Wherever the claims of the confined affections are in direct opposition to the dictates of the enlightened conscience, there can be no room for doubt, though we ought to be careful that our departure from their claims not only is, but, if possible, shall appear to be, demanded by these dictates; but we are even in cases which, independently considered, are obvious to take into consideration the evil that will result from a breach of those affections. There are some affections which not all the efforts of philosophy could succeed in eradicating; vice may do it and heedless levity, but the calm exertion arising from a view to utility never could. We refer to the parental affections. Hence it is, probable, that a sacrifice of them to the public good, would be productive of much less injury, than a sacrifice of the filial affections which are less urgent and lasting. Hence, though we should condemn the parent who left his son to perish in the flames, while he endeavoured to save the life of Fenelon, and should require strong proof that the parental affections existed in him, in their due force; yet we should doubly condemn the son who in such a case left his father to perish.—Godwin's principles, if carried to their fair extent, would destroy society; but we do not consider his errors as more than the errors of judgment. We suppose that the ardour of general benevolence misled him, and that in his wish to make its dictates paramount in the human breast, he forgot, or rather did not observe, that he was aiming to counteract the most essential laws of the human frame. It is one of those numerous instances in which an acquaintance with the human mind is necessary; had Godwin attended to its laws,

it is reasonable to hope that he never would have given a theory to the world, which, even a slight acquaintance with its practicability and effects, should have consigned to oblivion.

89. Seventhly, benevolent and religious persons have, all other things being equal, a prior claim to the rest of mankind. Natural benevolence itself teaches this as well as the moral sense. Two reasons strongly inforce this; in the first place we thus do what we can towards the promotion of goodness, we add something to the strength of the motives which exist even in the present life, for steady adherence to the practice of virtue. If it be our aim to remove misery without discrimination, we in some degree break down the barriers of virtue; we cannot remove all, therefore, let our efforts be directed so that they shall tell as completely as possible, and it is obvious that this will be most the case where what we do discourages vice in all its shapes. If indolence be secure of relief from that pressure which it places upon itself, indolence will be increased; if the appearance of misery be the only passport to our assistance, vice will be continually receiving encouragement.—But it is not merely with a view to the relief of actual misery that discrimination is important; it is equally important with respect to the extension of the means of doing good. We may confidently expect all the opportunities and powers we can commit to others will be most serviceable in the hands of those whose habits are formed upon the model of benevolent piety.—In all cases, however, especially while our benevolence is incipient, we are in some measure to be guided by its mere impulse.—It is one important consequence of doing good to others, that we do good to ourselves, we cultivate our benevolence, and with it cultivate our happiness. But that benevolence will be found to rest upon the surest footing, which is made to prompt to exertions which shall not interfere with the most extensive interests of man.

90. Eighthly, since the concerns of religion and a future state are of infinitely more importance than those which relate to this world, it should be our most earnest object to contribute, as far as in us lies, to the moral and religious improvement of our fellow-creatures. In various ways we have this power; and this is a field in which all can, more or less, employ their talents. Here no effort can be altogether thrown away; at least no effort will be prejudicial; and if to others they will be useless, their effects return to our own bosoms.

91. Ninthly, we ought to pay the strictest regard to truth both in our affirmations and promises. There are very few instances where veracity of both kinds is not evidently conducive to the public good, and falsehood in every degree pernicious. It follows, therefore, that, in cases where appearances are otherwise, the general regard to truth, which is of so much consequence to the world, ought to make us adhere inviolably to it; and that it is a most dangerous practice to falsify, as is often done, from false delicacy, or even from those motives which border upon virtue. The harm which these things do, by creating a mutual diffidence, and tendency to deceive, is incalculable; and perhaps in no instance to be counterbalanced by the present good effects assigned as the reason for their practice.

92. Tenthly, obedience to the civil magistrate, and to the laws of the community, is a subordinate general rule of the greatest importance.—It is evidently for the public good that every member of a state should submit to the governing power, whatever that be. Peace, order, and harmony result from this in the general; confusion and mischief of all kinds from the contrary. So that, though it may, and must be supposed, that disobedience in certain particular cases will, as far as the single act and its immediate consequences are considered, contribute more to the public good than obedience, yet as it is a dangerous example to others, and will probably lead the person himself into other instances of disobedience afterwards, disobedience becomes, in every case, upon the whole, of a tendency destructive of the public welfare. We ought, therefore, in consequence of this rule, to respect all persons in authority; not to pass hasty censures upon their actions; to make candid allowances on account of the difficulties of government, the bad education of princes, and of persons of high birth, and the flattery and extraordinary temptations with which they are surrounded; to observe the laws ourselves, and to promote the observance of them where the penalties may be evaded, or are found insufficient; to look upon property as a thing absolutely determined by the laws, so that, though a man may, and ought to rescind from what the law would give him out of compassion, generosity, love of peace, view of greater good upon

ion will restrain all actions which are excessive, irregular, or hurtful; will support and encourage us in all such as are of a contrary nature; and will infuse such peace and tranquillity of mind as will enable us to see clearly, and act uniformly. The perfection therefore of every part of our natures must depend upon the perfection in which the love of God, and a constant sense of his presence, have obtained possession of the mind.

96. With respect to the support and regulation afforded by piety to benevolence, it may be observed, that the love of our fellow men can never be free from personality and selfishness, until we are able to view all things in the relation which they bear to God. If the relation to ourselves be made the point of view, our prospects must be narrow, and the appearance of what we do see, distorted. When we consider the scenes of vanity, folly, and misery, which present themselves to our view from this point; when we are disappointed in the happiness of our friends, or feel the resentment of our enemies, our benevolence will begin to languish, and our hearts to fail us; we shall complain of the corruption and wickedness of that world which we have hitherto loved, with a benevolence merely human, and shew by our complaints that we are strongly tinctured with the same corruption and wickedness. This is generally the case with young and unexperienced persons in the beginning of a virtuous course, and before they have made advances in piety.—The disappointments which human benevolence meets with, are sometimes apt to incline us to call the divine goodness in question. But he who is possessed of a full assurance of this, who loves God with his whole powers, as an inexhaustible fountain of love and benevolence to his creatures, at all times and under all circumstances, as much when he chastises as when he rewards, will learn thereby to love enemies as well as friends, the sinful and miserable as well as the holy and happy; to rejoice and give thanks for every thing he sees and feels, however irreconcilable to his present suggestions; and to labour as an instrument under God, with real courage and consistency, for the promotion of virtue and happiness.

97. In like manner the conscience or moral sense requires a perpetual direction and support from the love of God to keep it steady and pure. When God is made only a subordinate end, or is shut out from the mind, men are very apt to relapse into negligence and callosity, and to act without any virtuous principle. And, on the other hand, if they regard him with slavish fear, they fill their minds with endless scruples and anxieties about the lawfulness of trivial actions.—Thus it regulates, improves, and perfects all the other parts of our nature; but further, it affords a pleasure superior in kind, and in degree, to all the rest of which our nature are capable.

98. First, the love and contemplation of God in some measure renders us partakers of the divine nature, and consequently of the perfection and happiness of it. Our wills may thus be united to his will, and therefore rendered free from disappointment; we shall by degrees see every thing as God sees it, that is, see every thing which he has made to be good. Though this can only be the case in part in the present world, yet it is well known that there have been those who have so far reached this perfection of our nature, as to acquiesce, and even to rejoice in the events of life, however apparently afflicting; to be freed from fear and solicitude; and to receive their daily bread with constant thankfulness. And though the number of these happy persons has been comparatively small, and the path be not frequented and beaten, yet if the desire be sufficiently earnest, it is in the power of all to arrive at the same state.

99. Secondly, the love of God may be considered as the central affection to which all the others point. When men have entered sufficiently into the ways of piety, the ideas of the Supreme Being recur more and more in the whole course and tenor of their lives, and, by uniting with all their sensations and intellectual feelings, overpower all the pains, and augment and connect with themselves all the pleasures. Every thing beautiful and glorious brings in the ideas of God, mixes with them, and coalesces with them; for all things are from God, he is the only cause and reality, and the existence of every thing else is only the effect and proof of his existence and excellence. Let the mind be once duly imbued with this truth, and its practical applications, and every thing will afford exercise for the devout affections. Add to their unlimited extent, their purity, and perfection, and it cannot but be acknowledged that they must be far superior to the rest both in kind and in degree.

100. Thirdly, the objects of other pleasures are frequently removed. No time,

no place, no circumstance of life can deprive us of this. Our hearts may be directed towards God in the greatest external confusion, as well as in the deepest silence and retirement. All the duties of life, when directed to God, become pleasures, and by the same means every the smallest action becomes the discharge of the proper duty of time and place. Thus time is turned to its best advantage: thus every situation of life may be converted into present comfort and future felicity.

101. Fourthly, when the love of God is thus made to arise from every object, and to exert itself in every action, it becomes of a permanent nature, and will not pass into deadness or disgust, as those other pleasures do from repeated gratification.

102. We should be glad if our limits would allow of our laying before our readers a view of those means which are pointed out by Hartley, for the culture of the theopathetic affections, of faith, fear, gratitude, hope, trust, resignation, and love: we must, however, content ourselves with referring to his 72d proposition on this point, and to his important rules in the 73d proposition, concerning the manner of expressing them in prayer, and other religious exercises; concluding this head with the following observations from the latter. There cannot be a more fatal delusion, than to suppose that religion is nothing but a divine philosophy in the soul; and that the foregoing theopathetic affections may exist and flourish there, though they be not cultivated by devout exercises and expressions. Experience, and many plain obvious reasons, shew the falsehood and mischievous tendency of this notion; and it follows from the theory of association, that no internal dispositions can remain long in the mind, unless they be properly nourished by proper associations, that is, by some external acts. This therefore, among others, may be considered as a strong argument for frequent prayer.

VII. ESTIMATE OF THE PLEASURES OF THE MORAL SENSE.

(PHILOSOPHY, *mental*, § 92—99.)

103. It has already been stated, that the moral sense ought to have great influence even in the most explicit and deliberate actions; hence the culture of its pleasures, and the correcting of its dictates, should be made a primary object of pursuit. Further, the moral sense, on urgent occasions, ought to have the sole influence; and this for several reasons.—First, because it offers itself at the various occasions of life, with consistency, and generally with certainty. It warns us beforehand, and calls us to account afterward; it condemns or approves; it rewards by the pleasures of self-approbation, or punishes by the pains of self-condemnation.—Secondly, the moral sense is principally generated by piety, benevolence, and rational self-interest. All these are explicit guides in deliberate actions; and since they are excluded, on sudden occasions, through the want of time to weigh and determine, it is highly reasonable to admit the moral sense formed from them, and whose dictates are immediate, as their substitute.—Thirdly, the greatness, the importance, and the calm nature, of the pleasures of the moral sense, with the horrors and the constant recurrence of the sense of guilt, are additional arguments to shew that these pleasures and pains were intended as the guides of life.

104. The perfection of the moral sense consists in the four following particulars; that it extend to all the actions of moment which occur in the intercourses of real life, and be a ready monitor on all such occasions: that its pleasures and pains should be so vivid as to furnish a very strong excitement to shun the path of vice, and to walk steadily in the way of religion: that it should not descend to trifling or minute particulars; for, though scrupulosity is probably a necessary step in the progress of mind to moral excellency, yet, if it continue and become the prevailing habit of the mind, it will check benevolence, and turn the love of God into a superstitious fear: lastly, it is necessary that the pleasures and pains of the moral sense should be perfectly conformable to the dictates of piety and benevolence, of which it may be considered as the substitute.

105. In order to obtain the most perfect state of the conscience, it is necessary for us to be much employed in the practical study of the sacred writings, and of the good of all denominations; in observing the living examples of goodness, and in the perusal of christian biography; in self-examination, and in the culture of the sympathetic and theopathetic affections; and in aiming to follow with faithfulness the dictates of piety, benevolence, and the moral sense, such as they are at present.

106. The moral sense may be, and often is, misled by education; the dictates of this feeling, therefore, are not a perfect

and infallible guide; though in persons well educated, they are decidedly favourable to virtue. Hence to cultivate and enlighten the moral sense in ourselves and in others, is a duty of the highest obligation; the most disastrous consequences have ensued, both to individuals and to society, from obedience to the dictates of misguided conscience.

107. Character, to use (with some variations) the words of Mr. Belsham, from whose Elements we have taken the last paragraph, is the sum total of moral habits and affections. That character is perfectly virtuous, all whose affections and habits tend to produce the greatest ultimate happiness of the agent, that is, in which all are perfectly consistent with pious benevolence, and in which every moral habit and affection is advanced to its most disinterested state. That character is perfectly vicious, all whose affections and habits tend to produce the greatest ultimate misery of the agent, and in which every vicious affection and habit exists in its ultimate state. The former character, though possible, is rarely to be found; but the tendency of moral discipline is to produce a continual approximation towards it; and it will probably be the ultimate state of all the rational creatures of God. The character of perfect vice is impossible; it never can actually exist; for no being can pursue misery for its own sake. That agent is said to be virtuous, though imperfectly so, all whose affections and habits tend to his own ultimate felicity, but not having attained their most perfect state, are subject to occasional deviations from the rules of piety and benevolence. That agent is denominated vicious, but imperfectly so, in whom there is one moral habit which tends to produce misery, or to diminish happiness: for example; intemperance, avarice, dishonesty, impiety. The reason is obvious. The existence of a single habit of this description is inconsistent with the perfect happiness of the agent, and necessarily involves him in proportional misery. So the prevalence of a single disorder is inconsistent with perfect health; and if a remedy be not applied in time, may be productive of the most fatal consequences.

PHILYDRUM, in botany, a genus of the Monandria Monogynia class and order. Essential character: spathe one-flowered; perianthium none; corolla four-petalled, irregular; capsule three-celled, many-seeded. There is but one species, viz. P. lanuginosum, a native of China and Cochin-China, in moist places.

PHLEBOTOMY, in surgery, the opening a vein with a proper sharp-edged and pointed instrument of steel, in order to let out a proper quantity of blood, either for the preservation, or recovery, of a person's health.

PHLEUM, in botany, *cat's-tail grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, sessile, linear, truncated, with a two-cusped tip; corolla inclosed. There are four species.

PHLOAS, in natural history, a genus of the Vermes Testacea class and order. Generic character: animal an ascidia; shell bivalve, divaricate, with several lesser differently shaped accessory ones at the hinge; hinges recurved, united by a cartilage; in the inside beneath the hinge is an incurved tooth. There are twelve species; they all perforate clay, spongy stones, and wood, while in the younger state, and as they increase in size, enlarge their habitation within, and thus become imprisoned. They contain a phosphoreous liquor, which illuminates whatever it touches.

PHLOGISTON, in chemistry, a term that seems to be almost wholly banished from our language. It was invented by Stahl, according to whom there is only one substance in nature capable of combustion, this he called phlogiston, and all those bodies which can be inflamed, contain more or less of it. Combustion, by his theory, is merely the separation of this substance. Those bodies which contain none of it are incombustibles. All combustibles are composed of an incombustible body and phlogiston united; and during the combustion the phlogiston flies off, and the incombustible body is left behind. Thus when sulphur is burnt, the substance that remains is sulphuric acid, an incombustible body. Sulphur therefore is said to be composed of sulphuric acid and phlogiston. This theory has long since given place to that established by Lavoisier. See COMBUSTION. It must, however, be observed that Professor Davy, in his late discoveries, seems inclined to admit of an inflammable principle, which pervades the whole of nature. How far his future experiments may lead to the establishment of the Lavoisierian theory, or that of Stahl, time only can show. See POTASSIUM, &c.

PHLOMIS, in botany, a genus of the

Didynamia Gymnospermia class and order. Natural order of Verticillatæ or Labiatæ. Essential character: calyx angular; corolla upper lip incumbent, compressed, villose. There are twenty-two species.

PHLOX, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rotaceæ. Polemonia, Jussieu. Essential character: corolla salver-shaped; filaments unequal; stigma trifid; calyx prismatical; capsule three-celled, one-seeded. There are twelve species, natives of North America.

PHOCA, the *seal*, in natural history, a genus of Mammalia of the order Feræ. Generic character: fore teeth, in the upper jaw, six, sharp, parallel, and the exterior ones larger; in the lower jaw four, distinct, parallel, equal, and rather blunt; tusks one on each side in both jaws, large and pointed, the upper remote from the fore teeth, the lower from the grinders; grinders five on each side above, and six below, tricuspidated. There are nineteen species, of which we shall notice the following:

P. vitulina, or the common seal, or sea-calf. These animals are found on the coasts of the polar regions, both to the north and south, often in extreme abundance, and are generally about five feet in length, closely covered with short hair. They swim with great vigour and rapidity, and subsist on various kinds of fish, which they are often observed to pursue within a short distance from the shore. They possess no inconsiderable sagacity, and may, without much difficulty, if taken young, be familiarized to their keepers, and instructed in various gesticulations. They are supposed to attain great longevity. The female is particularly attentive to her young, and scarcely ever produces more than two at a birth, which, after being suckled a fortnight on the shore, where they are always born, are conducted to the water, and taught by their dam the means of defence and subsistence; and when they are fatigued by their excursions, are relieved by being taken on her back. They distinguish her voice, and attend at her call. The flesh of seals is sometimes eaten, but they are almost always destroyed for their oil and skins. The latter are manufactured into very valuable leather, and the former is serviceable in a vast variety of manufactures. A young seal will supply about eight gallons of oil. The smell of these animals, in any great number upon the shore, is highly disagreeable. In the month of October they are generally considered as most valuable, and as they abound in extended caverns on the coast, which are washed by the tide, the hunters proceed to these retreats about midnight, advancing with their boat as far into the recess as they are able, armed with spears and bludgeons, and furnished with torches, to enable them to explore the cavern. They begin their operations by making the most violent noises, which soon rouse the seals from their slumbers, and awaken them to a sense of extreme danger, which they express by the most hideous yellings of terror. In their eagerness to escape they come down from all parts of the cavern, rushing in a promiscuous and turbulent mass along the avenue to the water. The men engaged in this perilous adventure oppose no impediment to this rushing crowd, but as this begins to diminish, apply their weapons with great activity and success, destroying vast numbers, and principally the young ones. The blow of the hunter is always levelled at the nose of the seal, where a slight stroke is almost instantly fatal.

P. ursina, or the ursine seal, grows to the length of eight feet, and to the weight of a hundred pounds. These are found in vast abundance in the islands between America and Kamtschatka, from June till September, when they return to the Asiatic or American shores. They are extremely strong, surviving wounds and lacerations which almost instantly destroy life in other animals, for days, and even weeks. They may be observed, not merely by hundreds, but by thousands on the shore, each male surrounded by his females, from eight to fifty, and his offspring, amounting frequently to more than that number. Each family is preserved separate from every other. The ursine seals are extremely fat and indolent, and remain with little exercise, or even motion, for months together upon the shore. But if jealousy, to which they are ever alive, once strongly operate, they are roused to animation by all the fierceness of resentment and vengeance, and conflicts arising from this cause between individuals, soon spread through families, till at length the whole shore becomes a scene of the most horrid hostility and havoc. When the conflict is finished, the survivors plunge into the water to wash off the blood, and recover from their exhaustion. Those which are old, and have lost the solace of connu-

bital life, are reported to be extremely captious, fierce, and malignant, and to live apart from all others, and so tenaciously to be attached to the station, which pre-occupancy may be supposed to give each a right to call his own, that any attempt at usurpation is resented as the foulest indignity, and the most furious contests frequently occur in consequence of the several claims for a favourite position. It is stated, that in these combats two never fall upon one. These seals are said, in grief, to shed tears very copiously. The male defends his young with the most intrepid courage and fondness, and will often beat the dam, notwithstanding her most supplicating tones and gestures, under the idea that she has been the cause of the destruction or injury which may have occurred to any of them. The flesh of the old male seal is intolerably strong; that of the female and the young is considered as delicate and nourishing, and compared in tenderness and flavour to the flesh of young pigs.

The bottle-nosed seal is found on the Falkland Islands, is twenty feet long, and will produce a butt of oil, and discharge, when struck to the heart, two hogsheads of blood.

PHŒNICOPTEROS, the *flamingo*, in natural history, a genus of birds of the order Grallæ. Generic character: bill naked, toothed, bending in the middle, as if broken; nostrils covered above with a thin plate, and linear; tongue cartilaginous and pointed; neck, legs, and thighs exceedingly long; feet webbed, back toe very small. The P. rubra, or common flamingo, the only species noticed by Latham, is nearly of the size of a goose, and upwards of four feet long. When mature in plumage, these birds are all over of the most deep and beautiful scarlet; but this maturity they never acquire till their third year. They are found in France, Spain, and Italy, in Syria and in Persia, but more frequently than any where else, on the coast of Africa downwards to the Cape. They build their nest of mud, in the shape of a hillock, and in a cavity on the top of it the female deposits two white eggs, on which she sits, having her legs stretched out one on each side of the hillock. The young ones run with great swiftness, but are unable to fly till they have attained nearly their complete growth. They subsist chiefly on small fishes, ova, and water insects, and frequent, during the day, the borders of rivers and lakes, withdrawing at night to the high grounds, and lodging amidst the long grass. They are extremely shy, and are stated, almost always, unless in the breeding season, to keep together in flocks, having a centinel ever vigilant at his post, by whom the slightest approaching danger is announced, by intimations which produce immediate flight. Their flesh is thought by some not inferior to that of the partridge, but their tongue was one of the most valued dainties of Roman epicurism. They have been sometimes reared tame, but are with difficulty preserved, and their susceptibility of cold is exquisite.

PHŒNIX, in astronomy, one of the constellations of the southern hemisphere, unknown to the ancients, and invisible in our northern parts. This constellation is said to consist of thirteen stars.

PHŒNIX, in botany, a genus of the Appendix Palmæ. Natural order of Palms. Essential character: calyx three-parted; corolla three-petalled: male, stamina three; female, pistil one; drupe ovate. There are two species, *viz.* P. dactylifera, date palm-tree, and P. farinifera, natives of the Levant and Coromandel.

PHONICS, the doctrine or science of sounds. See ACOUSTICS. This science has been considered as analogous to that of optics, and is divided into direct, refracted, and reflected; these have been called phonics, diaphonics, and cataphonics; but the terms are now well nigh obsolete. Phonics is a science that may be improved with regard to the object, the medium, and the organ. The object may be improved with respect to the production and propagation of sounds. With regard to the medium, phonics may be improved by its thinness and quiescency, and by the sonorous body being placed near a smooth wall, either plain or arched, more especially if it be formed after some peculiar curve, as from this arises the theory and practice of whispering places. Sound is much sweetened if it is propagated in the vicinity of water, and on a plain, it will be conveyed much further than on uneven ground.

PHORMIUM, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: calyx none; corolla six-petalled, the three inner petals longer; capsule oblong, three-sided; seeds oblong, compressed. There is but one species, *viz.* P. tenax, New Zealand flax-plant. The inhabitants of New Zealand make a thread of the leaves, with which the

women weave a variety of fine matting for clothing, and several other purposes. It is also manufactured in Norfolk Island for canvass and coarse linen cloths.

PHOSPHATES, in chemistry, salts formed of the phosphoric acid, with earths, alkalies, &c. The alkaline phosphates are soluble and crystallizable; they are also fusible, forming a kind of glass, and facilitate the fusion of a number of other substances. They may be decomposed in the humid way, by sulphuric and some other acids; but in the dry way these decompositions do not often happen. The phosphate of soda is much used in medicine; it is purely saline, without any bitterness, which renders it a good substitute for Epsom and Glauber's salts. As it melts easily, and promotes the fusion of the earths and metallic oxides, it is used in chemical operations as a flux. Phosphate of ammonia exists in the urine of carnivorous animals, in considerable quantity, united with phosphate of soda, forming a triple salt, formerly denominated microcosmic, or fusible salt, in urine.

PHOSPHITES, are salts formed of the phosphorous acid, with alkalies, earths, &c. In several of their properties they resemble the phosphates; but may be distinguished from them, by appearing luminous when heated with the blow-pipe, and by affording, by distillation, a small quantity of phosphorus. They detonate, too, with oxymuriate of potash, and precipitate gold from its solution in a metallic state. By exposure to the air, they pass into phosphates.

PHOSPHORESCENCE, } See LIGHT.
PHOSPHORI, }

PHOSPHORIC *acid*. When phosphorus undergoes combustion in oxygen gas, a great quantity of white fumes are produced, which are deposited in white flakes. These are phosphoric acid; so that it is a compound of phosphorus and oxygen. The phosphoric acid was first shewn to be distinct from all other acids, in the year 1743, by Margraaff. He found that it existed in the salts which were taken from human urine, and that phosphorus could only be obtained from this acid; as well as that it could be converted into phosphoric acid. This acid was found to exist in some vegetable substances, although it was formerly supposed to be peculiar to animal matters. Phosphoric acid may be obtained not only by the method just mentioned, but also by transmitting a current of oxygen gas through phosphorus melted under water. The acid, as it is formed, combines with the water, from which it may be obtained in a state of purity by evaporation. The specific gravity of this acid varies according to the different states in which it exists. In the liquid state it is 1.4; in the dry state it is 2.7; in the state of glass 2.85. It changes the colour of vegetable blues to red; has no smell, but a very acid taste. When it is exposed to the air it attracts moisture, and is converted into a thick viscid fluid like oil. It is very soluble in water. When in the form of dry flakes, it dissolves in a small quantity of this liquid, producing a hissing noise like that of a red-hot iron plunged into water, with the extrication of a great quantity of heat. The component parts of this acid have been accurately ascertained by Lavoisier, and it consists of,

Oxygen	60
Phosphorus	40
	100

It combines with the alkalies, earths, and metallic oxides, and forms salts which are denominated phosphates.

PHOSPHORITE, in mineralogy, is of a yellowish white, frequently spotted with grey: it occurs massive; internally it is glistening, sometimes dull; it is translucent on the edges, soft, brittle, and not very heavy. It forms a great bed in the province of Estremadura in Spain. In appearance it resembles curved, lamellar, heavy-spar; but it is harder and lighter than this kind of heavy-spar.

PHOSPHOROUS *acid*, is obtained by the slow combustion of phosphorus at the common temperature of the air. If phosphorus, in small pieces, be exposed to the air in a glass funnel placed in a bottle, it attracts the oxygen and moisture from the atmosphere, and runs down into the bottle. This is the phosphorous acid. By this process, about three times the weight of the phosphorus is obtained. It is then in the form of a white thick liquid, adhering to the sides of the vessel. It varies in consistence according to the state of the air. Its specific gravity is not known. It has an acid pungent taste, not different from phosphoric acid. It also reddens vegetable blue colours. The phosphorous acid is not altered by light. When exposed to heat in a retort, part of the water combined with it is first driven off, and when it is concentrated, bubbles of air suddenly rise to the surface, and collect in the form of white smoke, and

sometimes inflame, if there be any air in the apparatus. If the experiment be made in an open vessel, each bubble of air, when it comes to the surface, produces a vivid deflagration, and diffuses the odour of phosphorated hydrogen gas. This acid is composed of the same constituent parts as the phosphoric, and is considered by some as the phosphoric acid holding in solution a small quantity of phosphorus. Phosphorous acid forms compounds with alkalies, earths, and metallic oxides, which are known under the name of phosphites.

PHOSPHORUS. This singular substance was accidentally discovered in 1677 by an alchymist of Hamburgh, named Brandt, when he was engaged in searching for the philosopher's stone. Kunkel, another chemist, who had seen the new product, associated himself with one of his friends, named Krafft, to purchase the secret of its preparation; but the latter deceiving his friend, made the purchase for himself, and refused to communicate it. Kunkel, who at this time knew nothing further of its preparation than that it was obtained by certain processes from urine, undertook the task, and succeeded. It is on this account that the substance long went under the name of Kunkel's phosphorus. Mr. Boyle is also considered as one of the discoverers of phosphorus. He communicated the secret of the process for preparing it to the Royal Society of London in 1680. It is asserted, indeed, by Kraft, that he discovered the secret to Mr. Boyle, having in the year 1678 carried a small piece of it to London to shew it to the royal family; but there is little probability that a man of such integrity as Mr. Boyle would claim the discovery of the process as his own, and communicate it to the Royal Society, if this had not been the case. Mr. Boyle communicated the process to Godfrey Hankwitz, an apothecary of London, who for many years supplied Europe with phosphorus, and hence it went under the name of English phosphorus. In the year 1774, the Swedish chemists, Gahn and Scheele, made the important discovery, that phosphorus is contained in the bones of animals, and they improved the processes for procuring it.

The most convenient process for obtaining phosphorus seems to be that recommended by Fourcroy and Vauquelin, which we shall transcribe. Take a quantity of burnt bones, and reduce them to powder. Put 100 parts of this powder into a porcelain or stone-ware bason, and dilute it with four times its weight of water. Forty parts of sulphuric acid are then to be added in small portions, taking care to stir the mixture after the addition of every portion. A violent effervescence takes place, and a great quantity of air is disengaged. Let the mixture remain for twenty-four hours, stirring it occasionally, to expose every part of the powder to the action of the acid. The burnt bones consist of the phosphoric acid and lime; but the sulphuric acid has a greater affinity for the lime than the phosphoric acid. The action of the sulphuric acid uniting with the lime, and the separation of the phosphoric acid, occasion the effervescence. The sulphuric acid and the lime combine together, being insoluble, and fall to the bottom. Pour the whole mixture on a cloth filter, so that the liquid part, which is to be received in a porcelain vessel, may pass through. A white powder, which is the insoluble sulphate of lime, remains on the filter. After this has been repeatedly washed with water, it may be thrown away; but the water is to be added to that part of the liquid which passed through the filter. Take a solution of sugar of lead in water, and pour it gradually into the liquid in the porcelain bason. A white powder falls to the bottom, and the sugar of lead must be added so long as any precipitation takes place. The whole is again to be poured upon a filter, and the white powder which remains is to be well washed and dried. The dried powder is then to be mixed with one-sixth of its weight of charcoal powder. Put this mixture into an earthen-ware retort, and place it in a sand bath, with the beak plunged into a vessel of water. Apply heat, and let it be gradually increased, till the retort becomes red hot. As the heat increases, air-bubbles rush in abundance through the beak of the retort, some of which are inflamed when they come in contact with the air at the surface of the water. A substance at last drops out similar to melted wax, which congeals under the water. This is phosphorus. To have it quite pure, melt it in warm water, and strain it several times through a piece of shamoy leather under the surface of the water. To mould it into sticks, take a glass funnel with a long tube, which must be stopped with a cork. Fill it with water, and put the phosphorus into it. Immerse the funnel in boiling water, and when the phosphorus is melted, and flows into the tube of the funnel, then plunge it into cold water; and when the phosphorus has become solid,

remove the cork, and push the phosphorus from the mould with a piece of wood. Thus prepared, it must be preserved in close vessels, containing pure water. When phosphorus is perfectly pure, it is semi-transparent, and has the consistence of wax. It is so soft, that it may be cut with a knife. Its specific gravity is from 1.77 to 2.03. It has an acrid and disagreeable taste, and a peculiar smell, somewhat resembling garlic.

When a stick of phosphorus is broken, it exhibits some appearance of crystallization. The crystals are needle-shaped, or long octahedrons; but to obtain them in their most perfect state, the surface of the phosphorus, just when it becomes solid, should be pierced, that the internal liquid phosphorus may flow out, and leave a cavity for their formation. When phosphorus is exposed to the light it becomes of a reddish colour, which appears to be an incipient combustion. It is therefore necessary to preserve it in a dark place. At the temperature of 99° it becomes liquid, and if air be entirely excluded, it evaporates at 219°, and boils at 554°. At the temperature of 43° or 44°, it gives out a white smoke, and is luminous in the dark. This is a slow combustion of the phosphorus, which becomes more rapid as the temperature is raised. When phosphorus is heated to the temperature of 148° it takes fire, burns with a bright flame, and gives out a great quantity of white smoke. Phosphorus enters into combination with oxygen, azote, hydrogen, and carbon. Phosphorus is soluble in oils, and when thus dissolved forms what has been called liquid phosphorus, which may be rubbed on the face and hands without injury. It dissolves too in ether, and a very beautiful experiment consists in pouring this phosphoric ether in small portions, and in a dark place, on the surface of hot water. The phosphoric matches consist of phosphorus extremely dry, minutely divided, and perhaps a little oxygenized. The simplest mode of making them is to put a little phosphorus, dried by blotting paper, into a small phial; heat the phial, and when the phosphorus is melted turn it round, so that the phosphorus may adhere to the sides. Cork the phial closely, and it is prepared. On putting a common sulphur match into the bottle, and stirring it about, the phosphorus will adhere to the match, and will take fire when brought out into the air.

PHOSPHURETS, in chemistry, are substances formed by an union with phosphorus; thus we have the phosphuret of carbon, which is a compound of carbon with phosphorus: we have also the phosphuret of lime, hydrogen, &c.

PHOSPHURETTED *hydrogen*, phosphorus dissolved in hydrogen gas; which may be done by introducing phosphorus into a glass jar of hydrogen gas standing over mercury, and then melting it by means of a burning glass; the gas dissolves a large proportion of it. The compound has a very fetid odour, something like that from putrid fish. When it comes into contact with common air, it burns with great rapidity, and if mixed with that air it detonates violently. Oxygen gas produces a still more rapid and brilliant combustion than common air. When bubbles of it are made to pass up through water, they explode in succession as they reach the surface of the liquid; a beautiful column of white smoke is formed. This gas is the most combustible substance known. Its combustion is the combination of its phosphorus and hydrogen with the oxygen of the atmosphere, and the products are phosphoric acid and water. These substances, mixed or combined, constitute the white smoke.

PHOTOMETER, an instrument intended to indicate the different quantities of light, as in a cloudy or bright day, or between bodies illuminated in different degrees. The ratio of the intensities of two luminous objects has been attempted to be measured by placing them at different distances from a given object, until that object cast two shadows of equal darkness; or by observing when two equal objects appeared to be equally illuminated each by one of the luminous objects; for then by a well known and established law, the proportion of the intensities of their light was supposed to be as the squares of the distances. Thus if two equal objects appear to be equally illuminated, when one of them is three feet from a tallow candle, and when the other is nine feet from a wax candle, then it is inferred that the intensity of the light of the former candle is to that of the latter as nine to eighty-one. Mr. Leslie has more recently invented an instrument of this kind, the essential part of which consists of a glass tube like a reversed syphon, whose two branches should be equal in height, and terminated by balls of equal diameter; one of the balls is of black enamel, and the other of common glass, into which is put some liquid.

The motions of the liquor, which is sulphuric acid tinged red with carmine, are

measured by means of a graduation, the zero is situated towards the top of the branch that is terminated by the enamelled ball. The use of this instrument is founded upon the principle, that when the light is absorbed by a body, it produces a heat proportional to the quantity of absorption. When the instrument is exposed to the solar rays, those rays that are absorbed by the dark colour, heat the interior air, which causes the liquor to descend at first with rapidity in the corresponding branch. But as a part of the heat which had introduced itself by means of the absorption is dissipated by the radiation, and as the difference between the quantity of heat lost and that of the heat acquired goes on diminishing, there will be a point where these two quantities having become equal, the instrument will be stationary, and the intensity of the incident light is then estimated by the number of degrees which the liquor has run over. The author of this ingenious instrument has pointed out its advantages in determining the progressive augmentation undergone by the intensity of the light, and the gradation in a contrary sense which succeeds to that progress, both from the beginning of the day to its end, and from the winter solstice to the end of the succeeding autumn. With the help of such an instrument one might also compare the action of rays of light in different countries of which some dart with sufficient constancy from a fine and serene sky, while others seem to be covered with a veil which dims and obscures their lustre. Mr. Leslie having proposed to himself, to measure the energy of the several coloured rays which compose the solar spectrum, caused a beam of light to pass through a prism of flint glass; and the indications of the photometer presented successively to the different parts of the spectrum, have furnished nearly for the relation, between the degrees of force of the blue, green, yellow, and red rays, that of the numbers 1, 4, 9, 16; a relation which, considered in the two extreme terms, is more than quadruple that which was substituted for it by Dr. Herschel, who has made experiments for the same purpose.

PHRYGANEA, in natural history, a genus of insects of the order Neuroptera. Generic character: mouth with a horny short curved mandible; feelers four; three stemmata; antennæ setaceous, longer than the thorax; wings equal, incumbent, the lower ones folded. There are nearly sixty species in two divisions. A. Tail with two truncate bristles. B. Tail without bristles. The insects of this genus are seen in a summer's evening floating in the air in large masses, and are eagerly devoured by swallows. They resemble moths, particularly the division called Tineæ; but may readily be distinguished by their feelers, and also by the stemmata situated at the top of the head. The phryganeæ proceed from aquatic larvæ of a lengthened shape, residing in tubular cases, which they form by agglutinating various fragments of vegetable substances, &c. These tubular cases are lined within by a tissue of silken fibres, and are open at each extremity. The included larvæ, when feeding, protrude the head and fore-parts of the body, creeping along the bottom of the waters they inhabit, by means of six short and slender legs; on the upper part of the back, is a sort of prop, preventing the case, or tube, from slipping too forwards during the time the animal is feeding. One of the largest species is the P. grandis, (see Plate IV. Entomology, fig. 2). This insect is about an inch in length, very like a phalæna; the upper wings are grey, marked by various darker and lighter streaks and specks, and the under wings yellowish, brown, and semitransparent. The larvæ of this genus is known by the name of cadew-worm, and is frequently used by anglers as a bait. When arrived at full growth it fastens the case or tube by several silken filaments to the stem of some water plant, or other convenient substance, in such a manner as to project a little above the surface of the water, and casting its skin, changes to a chrysalis of a lengthened shape, and displaying the immature limbs of the future phryganea, which in a fortnight emerges from its confinement.

PHRYMA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Personatæ. Labiatæ, Jussieu. Essential character: seed one. There are two species, viz. P. leptostachya and P. dehiscens; the former is a native of North America, the latter was found at the Cape of Good Hope by Thunberg.

PHRYNIUM, in botany, a genus of the Monandria Monogynia class and order. Essential character: calyx three-leaved; petals three, equal, growing to the long channelled tube of the nectary; nectary tube filiform; border four-parted; capsule three-celled; nuts three. There is but one species, viz. P. capitatum, which is a native of Malabar, China, and Cochin China, in shady moist places.

PHTHISIS, a species of consumption, arising from an ulcer of the lungs. See MEDICINE.

PHYLACTERY, in antiquity, a charm, or amulet, which being worn, was supposed to preserve people from certain evils, diseases, and dangers.

PHYLLACHNE, in botany, a genus of the Dioecia Monandria class and order. Essential character: calyx three-leaved, superior; corolla funnel form: female, stigma four-cornered; capsule inferior, many seeded. There is only one species, *viz.* P. uliginosa, a small mossy plant, growing in tufts; stems closely approximating, covered with imbricate leaves, proliferous into two or three branchlets; leaves small, awl-shaped, flowers terminating, sessile, white; this plant has the structure of a moss, but adorned with flowers of a very different kind. It is a native of Terra del Fuego.

PHYLLANTHUS, in botany, a genus of the Monoecia Triandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx six-parted, bell-shaped; corolla none: female, calyx six-parted; corolla none; styles three, bifid; capsule three-celled; seeds solitary. There are eleven species, among which we shall notice the P. niruri, annual phyllanthus, this is a plant, with an herbaceous stalk a foot and half in height; the leaflets contract every evening, turning their under side outwards; the flowers are produced on the under side of the leaves along the midrib, and turn downwards; it usually flowers here from June to October; the seeds ripen in succession, and are cast out of the capsules, when ripe, with so much force, as to be thrown to a considerable distance; it is very common in Barbadoes and Japan.

PHYLICA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: perianth five-parted, turbinate; petals none, but five scales defending the stamens; capsule tricoccous, inferior. There are twenty species, of which P. ericoides, heath-leaved phylica, is a low bushy plant, seldom more than three feet in height; the stalks are shrubby and irregular, dividing into many spreading branches; at the end of every shoot, the flowers are produced in small clusters, sitting close to the leaves, of a white colour; they begin to appear in the autumn, continue in beauty all the winter; they decay in spring; it grows naturally at the Cape of Good Hope; it also occupies large tracts of ground about Lisbon, in the same manner as many lands in England are covered with heath.

PHYLLIS, in botany, a genus of the Pentandria Digynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: stigmas hispid; fructifications scattered; calyx two-leaved, obsolete; corolla five-petalled; seeds two. There is but one species, *viz.* P. nobla, bastard hare's ear, a native of the Canary islands.

PHYSALIS, in botany, *winter-cherry*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla wheel-shaped; stamina converging; berry within an inflated calyx, two-celled. There are seventeen species, of which the P. alkekengi, common winter-cherry, has a perennial root, creeping to a considerable distance; it shoots up many stalks in the spring; leaves of various shapes, of a dark green colour, on long foot stalks; flowers axillary, on slender peduncles; berry round, the size of a small cherry, inclosed in the inflated calyx; it is a native of the south of Europe.

PHYSETER, the *cachalot*, in natural history, a genus of Mammalia of the order Cete. Generic character: teeth perceivable in the lower jaw only; spiracle on the head. There are four species, P. macrocephalus, or the spermaceti whale, is sixty feet in length, and the head is nearly one-third of the bulk of the whole animal. It is found in the European seas, and on the coasts of New England, swims with extreme swiftness, and persecutes the white shark with violent and fatal enmity. The lump fish, also, it pursues with great avidity. It is one of the most difficult of all whales to be taken, and survives for several days, the deepest wounds given it by the harpoon. Its skin, oil, and tendons are all converted by the Greenlanders to some valuable purpose, and its flesh is not altogether rejected by them. The spermaceti is found in a vast hollow in the head of this animal, and, when warm, is nearly fluid, but dries by exposure to the air into flaky masses. Ambergris, also, is produced by this species, and consists in fact of the fæces of the animal. The origin of this substance had long baffled the curiosity of the enquirer, but is at length unquestionably ascertained.

PHYSICIANS. By statute 3 Hen. VIII. c. 11, no person within London, nor within seven miles of the same, shall practice as a physician or surgeon, except he be examined and approved by the Bishop of London, or by the Dean of St. Paul's, assisted by four persons of the faculty, under a penalty of 5*l.* per month, half to the King, and half to the informer. A doctor of physic of the Universities must still have a licence from the College of Physicians to enable him to practice in London, and within seven miles of the same. In the country such a doctor of physic may practice, but no other, without licence from the College. It has been said, it is murder if a person die under the care of a medical practitioner not qualified; but although it might be punishable as a misdemeanour, yet it certainly cannot be murder.

PHYSICS, a term made use of by Dr. Keil and others, for natural philosophy, explains the doctrine of natural bodies, their phenomena, causes, and effects, with the various affections, motions, and operations. Experimental physics inquire into the reasons and nature of things by experiments, as in hydrostatics, pneumatics, optics, &c. but more particularly in chemistry, in which more has been done the last thirty years than could possibly have been conceived by the imagination. Mechanical physics explain the appearances of nature from the matter, motion, structure, and figures of bodies, and their parts, according to the settled laws of nature. See MECHANICS.

PHYSIOGNOMY, is the peculiar combination of features, which designates the feelings and dispositions of the mind. That every individual of the human race possesses a set of distinctive marks, in the form of the head and the outlines of the countenance, is visible to the most inattentive observer; and it is well known, that those marks insensibly lead us to form conclusions as to the nature and inclinations of persons to whom we are introduced for the first time, which may sometimes be correct, but are frequently erroneous.

Every man is unconsciously a physiognomist, he feels a partiality or dislike, which partakes exceedingly of the sense of the lines in one of Richardson's novels.

> "I do not like thee, Dr. Fell,
> The reason why I cannot tell;
> But I do not like thee, Dr. Fell."

Admitting this fact, as to mankind in general, it will be proper to observe, that however the study of physiognomy may be commended and recommended, it should be exercised with great discretion and judgment, or very fatal, or, at least, very disagreeable consequences may be the result; for it must be remembered, that numerous causes exist to derange and discompose the human frame during infancy, and even before the birth, which may impress a character or expression on the features, descriptive of evil passions that never existed in the mind of the unfortunate person so situated; for instance, it would be inhuman to judge of the soul of one who has had the vertebræ of his back doubled, from the expression of his face, which is uniformly that of peevishness and confirmed ill-nature; nor would it be just, to think a man capable of every kind of wickedness, whose head and face bears the marks of malice, through a deformity existing perhaps before his birth. Were the bones incompressible from the instant they are formed, and the muscles incapable of being moulded to their shape, in short, did mankind receive a decided and unalterable outline from the Creator, we should then make correct conclusions from the beauty or irregularity of his face.

Having thus hinted at the impropriety of forming hasty conclusions, we shall give a sketch of what has been advanced on this subject by a person of great observation, and extremely capable of drawing just inferences, but who was rather tinctured by enthusiasm. Lavater asserts, that "each creature is indispensable in the vast compass of creation; but each individual," he adds, "is not alike informed of the truth of this fact, as man only is conscious that his own place cannot be supplied by another." The idea thus conceived, he thinks one of the best consequences of physiognomy, and he exults, that the most deformed and wicked persons are still superior to the most perfect and beautiful animal, because they always have it in their power to amend, and in some degree to restore themselves to the place assigned them in creation; and however their features may be distorted by the indulgence of their passions, still the image of the Creator remains, from which sin only is to be expelled, to render the likeness nearer perfection.

The aid of Lavater is not necessary to inform us, that there exists a national physiognomy, by which a stranger in any given country may be known by those who are possessed of previous observation, to be a

Spaniard, a German, or a Frenchman, and which impels even the very vulgar to exclaim, "He is a foreigner," though they cannot appropriate him to his country; but the mind of Lavater, being almost exclusively turned to this pursuit, we must profit and be informed by his relation of the distinguishing traits which point out the natives of different regions. This great physiognomist observes, that the placing of several persons together, selected from nations remotely sitnated from each other, gives at one glance their surprising varieties of visage; and yet he acknowledges, that to point out those variations is a task of considerable difficulty, and his assertion, that this may be done with more facility from an individual than the mass of population, seems extremely probable. The French, he thinks, do not possess equally commanding traits with the English, nor are they so minute as those of the Germans, and it is to the peculiarities of their teeth, and manner of laughing, that he attributed his power of deciding on their origin. The Italians he appropriated by the form of their noses, their diminutive eyes, and projecting chins. The eye-brows and foreheads are the criterion by which to judge of the natives of England. The Dutch possess a particular rotundity of the head, and have weak, thin hair: the Germans, numerous angles and wrinkles about the eyes and in the cheeks; and the Russians are remarkable for black and light-coloured hair, and flat noses.

It must be extremely grateful to the natives of England to reflect, that Lavater considers them, in the aggregate, the most favoured upon the earth with respect to personal beauty; he says, they have the shortest and best-arched foreheads, and that only upwards, and towards the eyebrows, sometimes gradually declining, and in other cases are rectilinear, with full, medullary noses, frequently round, but very seldom pointed, and lips equally large, well defined, curved, and beautiful, with the addition of full, round chins. Still greater perfections are attributed to the eyes of Englishmen, which are said to possess the expression of manly steadiness, generosity, liberality, and frankness, to which the eyebrows greatly contribute. With complexions infinitely fairer than those of the Germans, they have the advantage of escaping the numerous wrinkles found in the faces of the latter, and their general *contour* is noble and commanding.

Judging from the ladies he had seen of our country, and from numerous portraits of others, Lavater was led to say, they appeared to him wholly composed of nerve and marrow, tall and slender in their forms, gentle, and as distant from coarseness and harshness as earth from heaven. His own countrymen he found to have many characteristic varieties; those of Zurich are generally meagre, and of the middle size, and either corpulent or very thin.

To pursue this subject something further, it will be found, that the people of Lapland, and parts of Tartary, are of very diminutive stature, and of extremely savage countenances, formed by flat faces, broad noses, high cheek bones, large mouths, thick lips, peaked chins, and their eyes are of a yellow brown, almost black, with the lids retiring towards the temples; nor are the females of this disagreeable race more favoured by nature; and each sex is distinguished by the grossest manners, and minds stupid beyond credibility; but of all the varieties of the human species, the inhabitants of the coast of New Holland seem the most debased and miserable; those are tall and slender, and to add to the deformity of thick lips, large noses, and wide mouths, they are taught from their infancy to keep their eyes nearly closed, to avoid the insects which swarm around them.

Turning to the more favourable side of this picture of national physiognomy, we shall find the people of Cachemire, the Georgians, the Circassians, and Mingrelians, erect, noble, and formed for admiration, particularly the females, whose charms of face and person are proverbial.

There are too many local and physical causes for this difference in the external appearance of the inhabitants of the different parts of the world, for enumeration and explanation in so confined a space as that to which we are limited. Professor Kant, of Konigsberg, in an essay on this subject, divides the human race into four principal classes, into which the intermediate gradations may readily be resolved: those are the Whites, the Negroes, the Huns, (Monguls, or Calmucs), and the Hindoos, or people of Hindostan. Circumstances purely external may be the accidental, but cannot be the original causes of what is assimilated or inherited; as well could chance produce a body completely organized. "Man," says the Professor, "was undoubtedly intended to be the inhabitant of all climates and all soils. Hence the seeds of many in-

ternal propensities must be latent in him, which shall remain inactive, or be put in motion according to his situation on the earth: so that in progressive generation, he shall appear as if born for that particular soil in which he seems planted."

In the opinion of this gentleman, the air and the sun are the two causes which most powerfully influence the operations of propagation, and give a lasting developement of germ and propensities, or in other words, the above powers may be the origin of a new race.

Food may produce some slight variations, those, however, must soon disappear after emigration, and it is evident, that whatever affects the propagating powers, does not act upon the support of life; but upon the original principle, the very source of animal conformation and motion. It has been observed, that man degenerates in stature and faculties the nearer he is situated to the frigid zone; this seems a necessary consequence of that situation, for this obvious reason, were men of the common stature in those regions of extreme cold, the impelling power of the heart must be increased, to force the blood through the extremities, which would otherwise chill, and become totally useless; but as the Creator did not think it useful to adopt this mode of preserving the limbs, they have been shortened, for the purpose of confining the circulating fluid to the trunk, where the natural heat accumulating, the whole body has a greater proportion of that comfortable sensation than strangers feel when visiting those northern countries.

The propensity to flatness, observable in the prominent parts of the countenance of the persons under consideration, exposed to the effects of cold, is accounted for by that very circumstance; and it appears probable, that their high cheek-bones and small, imperfect eyes are so contrived, to preserve the latter from the piercing effects of the wind, and the offensive brilliancy of the almost eternal snows. The Abbé Winkelman attributes the enormous and disgusting lips of the Negroes to the heat of the climate they inhabit; others account for the blackness of their skin by suppposing, "the surplus of the feruginous, or iron particles, which have lately been discovered to exist in the blood of man, and which, by the evaporation of the phosphoric acidities, of which all Negroes smell so strong, being cast upon the retiform membrane, occasions the blackness which appears through the cuticle, and this strong retention of the ferruginous particles seems to be necessary, in order to prevent the general relaxation of the parts."

Professor Camper concludes, from long and attentive observation, applied to the skulls of the inhabitants of many different nations, which he had dissected in numerous cases soon after death, that it is extremely difficult to draw any head accurately in profile, and to define the lines of the countenance, and their angles with the horizon; but he thinks he has been thus led to the discovery of the maximum and minimum of this angle. He commenced his operations with the monkey, and proceeded with the Negro and European; and, finally, he examined the profiles of the most valuable statues of antiquity. With respect to the breadth of the cheek bones, he found that the largest were amongst the Calmucs, and considerably smaller amongst the Asiatic Negroes. The Chinese, the natives of the Molucca and other Asiatic Islands, appeared to him to have broad cheeks and projecting jawbones, particularly the under, which is very high, and almost forms a right angle: on the contrary, those of Europeans are extremely obtuse, and of Negroes even more so. Succeeding thus far, the Professor acknowledges he was foiled in his attempts to discriminate the differences in the European nations; nor was he more successful with the Jews, whose countenances are possessed of many marked peculiarities; and yet this gentleman asserts, he never had been able to draw them with any tolerable accuracy; and, in this particular, the Italian face was equally difficult.

Making due allowance for the aberrations of the imagination, the Professor either had, or conceited he had, attained the faculty of distinguishing the heads of English, Scots, and Irish soldiers; but he was incapable of describing the marks which announced their profession. More reliance may, however, be placed on his assertion, that the upper and under jaws of Europeans are less broad than the breadth of the skull, and that among the Asiatics they are much broader.

The most unequivocal proofs exist of family physiognomy, or in other words family resemblance. Buffon, Bonnet, Haller, and many others, have endeavoured to account for this circumstance, but, as may be supposed, without the least probable success; we shall therefore pass this part of the subject in silence, as it must be evident that we

have no kind of data on which to argue, nor can the secret operations of nature ever be penetrated which relate to the formation of man. Much of the general resemblance between members of a family depend upon a congeniality of sentiments and manners, each turn of thought gives a peculiar expression to the features, and as those are sufficiently strong to explain to what class they belong, to an indifferent spectator it is by no means improbable that they assist at least in designating a family. Very intimate friends are sometimes thought to resemble each other, and a real or fancied resemblance often occurs between mán and wife; when it is considered that connections of the above descriptions are very often formed by persons who had never previously seen each other, it is impossible to doubt but that the similarity of mind thus generated influences the muscles, and disposing them into the same kind of expression a muscular likeness occurs, which has no influence upon the bones, and would probably vanish were the connection dissolved, and the parties examined after long separation. Lavater indulged in many flights of fancy when treating on this part of the science of physiognomy; he even imagined, that a person deeply enamoured of another, and thinking intensely on the form and position of their features, might assume a resemblance of the admired object, though miles of space intervened between them; and pursuing his mental dream, he adds, that it is equally probable an individual meditating revenge in secret may compose his countenance into a likeness of him who was to be its victim. The incorrectness of the latter fancy may be exposed by merely observing that the person under the influence of the passion of revenge, must bear in his countenance the lines expressive of that restless affection, now as the object intended to be injured is unconscious of the secret machinations against him, he may at the instant be engaged in some benevolent pursuit, or may feel some internal joy which moulds his features into an expression directly opposite to that of his adversary, who may have generally seen him thus; for revenge is often aimed, by the wicked, at the best of men; consequently, the countenance of a fiend grinning with malice cannot at the same time beam with a complacency arising from a set of features entirely unruffled.

Before we enter upon a description of the marks which, according to Lavater, point out the character of the possessor, it may be proper to give one or two instances of the fallacy, and of the truth, of the conclusions drawn from them, in order that our readers may form their own conclusions, as to the folly, or propriety, of entertaining a propensity to form a judgement of mankind from the shapes of their noses, eyes, foreheads and chins.

M. Sturtz declared to Lavater that he "once happened to see a criminal condemned to the wheel, who, with satanic wickedness, had murdered his benefactor, and who yet had the benevolent, and open countenance of an angel of Guido. It is not impossible, adds this gentlemen, to discover the head of a Regulus among guilty criminals, or of a vestal in the house of correction." Lavater admits this assertion in its fullest extent, but his reasoning to reconcile it to his system is by no means conclusive.

When we hear of any atrocious act, the natural abhorrence of vice and cruelty implanted in us, leads the imagination to form a portrait of the perpetrator, suited to the deformity of the mind capable of committing it; without reflecting, that had such an index existed in the countenance of the abhorred object, it is most probable, his murderous and horrible exterior would have placed mankind so far on their guard as to detect his intentions. Upon viewing the culprit we are perhaps surprized to find that there is nothing particularly indicative of cruelty in the outlines of his face, and we industriously endeavour to force each into the immediate form of our pre-conceived portrait, this occasions us to read lurking villainy in his eyes, and converts the wrinkles of disease, or approaching age, into the frown of a dæmon; and we depart exclaiming against the striking contour of the miserable wretch, when, perhaps, many of our friends, and even relatives, would suffer by a comparison, and yet had led uniformly innocent lives. On the other hand it must be admitted, that vice generally stamps her votaries with marks, which may be known at a glance, but this admission applies only to the confirmed enemies of virtue, those whose habits of living are so uniformly vicious that very little propriety occurs in their conduct.

The following anecdote, related by Lavater, may serve as a partial illustration of the assertion, that the features are affected by the turn of the mind, or, perhaps, more correctly speaking, the muscles of the face.

An innocent, amiable, and virtuous young lady, of high birth, who had been educated in the retirement of the country, happened one evening to pass a mirror, immediately after having attended evening prayers, and with a candle in her hand was depositing a bible on a table, when she observed her image reflected in the glass: affected with a sense of humility, and of extreme modesty, she averted her eyes and retired. A succeeding winter was passed in the amusements and dissipation of a city, where this lady had the misfortune to forget all her previously devout pursuits; but returning to the country, she once more passed the glass and the bible, and saw her features reflected, now deprived of those fascinating graces which belong alone to the serene and happy state of mind she had lost. Alarmed at the change, she fled from the spot, and retiring to a sofa, ejaculated sentences of penitence, and formed resolutions of future amendment.

Lavater begins his remarks on the human face with the forehead. According to this observer, the general form, proportion, the arch, obliquity, and position of the scull of the forehead denotes the degree of thought, the sensibility, the mental vigour, and the propensities of man; and at the same time the skin of this part of the head explains by its hue, tension, or wrinkles, the state of the mind at the moment of observation, and the passions which influence it, the bones affording the internal quantity, and the covering the application of power: however the latter may be affected, it is well known that the bones must remain unaltered, and yet they regulate the wrinkles by their variation of component form. Wrinkles are produced by a certain degree of flatness; others arise from arching, and those considered separately will give the form of the arch, and *vice versa*. Some foreheads are furnished with wrinkles that are confined to horizontal, perpendicular, curved, and others confused and mixed lines; those least perplexed when in action are usually observed in foreheads without angles.

Lavater appears to have been the first who attended to the peculiar turns of the position and outline of the forehead, which he considered the most important part presented for the study of the physiognomist. This he divides into three classes, and those he termed the perpendicular, the projecting, and the retreating, each possessing a number of variations; the principal, however, are rectilinear, "half round, half rectilinear, flowing into each other; half round, half rectilinear, interrupted; curve-lined, simple; the curve-lined double and triple."

A long forehead denotes much capacity of comprehension, and less activity; a compressed, short, and firm forehead, more compression, stability, and little volatility; severity and pertinacity belong to the rectilinear; and the more curved than angular portends flexibility and tenderness of character: deficiency of understanding is discoverable in those whose foreheads are perpendicular from the hair to the eyebrows; but the perfectly perpendicular, gently arched at the top, signifies that the possessor thinks coolly and profoundly. The projecting forehead indicates stupidity and mental weakness; the retreating, exactly the reverse; the circular, and prominent above, with straight lines below, and nearly perpendicular, shews sensibility, ardour, and good understanding; the rectilinear, oblique forehead has the same properties; arched foreheads are considered as feminine; an union of curved and straight lines, happily disposed, with a similar position of the forehead, gives the character of consummate wisdom. "Right lines, considered as such, and curves, considered as such, are relaxed, as power and weakness, obstinacy and flexibility, understanding and sensation." When the bones surrounding the eye project, and are sharp, the person thus formed possesses a powerful stimulus to exercise a strong mental energy, which is productive of excellent and well digested plans, and yet this doth not seem a peculiar mark of wisdom, as many wise men have been known without it: those thus circumstanced have more firmness, when the forehead rests perpendicularly upon horizontal eyebrows, and is considerably rounded towards the temples. Perpendicular foreheads, which, however, project so as not to rest on the nose, and which are short, small, shine, and are full of wrinkles, give undoubted indications of a weakness of the thinking faculties; perseverance and oppressive violent activity, united with vigour and harshness, belong to the forehead composed of various confused protuberances; and on the other hand, when the profile of this part of the head affords two well proportioned arches, the lowest projecting, it is a certain sign of a good temperament and a sound understanding. All great and excellent men have been found to have their eye-bones firmly arched, and well defined; and circumspection, followed by stability, attends square

foreheads, with spacious temples, and eye-bones of the above description; when perpendicular natural wrinkles appear, they express power of mind and application; but horizontal, interrupted in the middle, or broken at the extremities, betray, in general, negligence, if not want of ability.

Deep indenting in the bones of the forehead situated between the eye-brows, and extending in a perpendicular direction, mark the happy few who possess generous and noble minds, connected with excellence of understanding; besides, a blue vena frontalis, in the form of a Y, situated in an arched smooth forehead, is an indication of similar advantages. Lavater having given the above hints, describes the following characteristics, which he asserts, give "the indubitable signs of an excellent, a perfectly beautiful and significant, intelligent, and noble forehead." Such must be one-third of the face in length, or that of the nose, and from the nose to the chin; the upper part must be oval, in the manner of the great men of England, or nearly square; the skin must be smooth, and wrinkled only when the mind is roused to just indignation, or deeply immersed in thought, and during the paroxysms of pain; the upper part must recede, and the lower project; the eye-bones must be horizontal, and present a perfect curve upon being observed from above; an intersecting cavity should divide the forehead into four distinct parts, but with that slight effect as to be only visible with a clear descending light; and all the outlines should be composed of such, that if the section of one-third only is observed, it would be difficult to decide whether they were circular or straight; to conclude this portrait of a transcendant forehead, the skin must be more transparent, and of a finer tint, than the remainder of the face. Should an infant, a relative, or friend, who possesses a forehead resembling the above description, seriously err, the good enthusiast entreats, that the corrector may not despair of success, as in all human probability the latent seeds of virtue may be roused into growth by perseverance, and finally produce the desired fruit.

The eyes of mankind are composed of various shades of colour, the most common of which are grey mixed with white, grey tinged with blue, and shades of green, orange, and yellow. According to Buffon, the orange and blue are most predominant, and those colours often meet in the same eye; those generally supposed to be black are not really so, and may be found, on attentive examination, and with a proper disposition of the light, to consist of yellow, a deep orange, or brown, which being violently opposed to the clear white of the ball, assumes a darkness mistaken for black. The same naturalist observes, that shades of yellow, orange, blue, and grey, are visible in the same eye, and when blue, even of the lightest tint, appears, it is invariably the predominant colour, and may be found in rays dispersed throughout the iris: the orange is differently disposed, at a trifling distance from the pupil, is in flakes, and round; but the blue so far overpowers it, that the eye assumes the appearance of being wholly of that colour. The fire and vivacity emitted by the eye cannot be so powerful in those of the lighter tints; it is therefore in the dark ones alone that we look for the emotions of the soul; quiet and mildness, and a certain degree of archness, are the characteristics of the blue. Some eyes are remarkable for the absence of colour; the iris is faintly shaded with blue or grey, and the tints of orange are so light that they are hardly observable; in eyes thus constituted, the black of the pupil appears too conspicuous, and it may be said that portion is alone visible at a little distance, which circumstance gives the person a ghastly and spiritless appearance.

There are eyes whose iris may be said to be almost green; but these are very uncommon. It would require the pen of an inspired writer to describe the astonishing variety of expression of which the eyes are capable: being situated near the supposed seat of the soul, every sensation of that invisible spirit appears to rush in full vigour from those intelligent organs: all the passions may be seen in them; we shrink from their indications of anger, we find pleasure with all her train of joys dancing in them, we feel their force in love, and melt into tears upon observing them suffused with the moisture of grief; in short their language is far more powerful than that of the tongue. The transitions are so rapid in the expression of the eyes, that it requires very close and attentive examination to catch and describe the emotions of the mind visible in them; admitting this fact, it will appear that the physiognomist is liable to numerous and egregious errors in drawing his conclusion of propensities from them. Paracelsus, a man of strong genius, and, like Lavater, misguided in many instances by enthusiasm, and a kind of superstition allied to the study

of this art or science, pronounced that those eyes generally termed black frequently denoted health, firmness, courage, and honour; but the grey, deceit and instability. Thus far probability at least accompanies his remarks. It is, however, impossible to subscribe to his assertion, that short-sighted persons are deceitful and crafty, or that those who squint have similar propensities to evil, as it is evident both the peculiarities alluded to are the consequences of injury, and are never found in people whose organs of vision are perfect: indeed many instances might be cited of the actual and known causes of squinting and near sight, which frequently occur in adults from extreme anxiety and disease.

Small eyes situated deep in the sockets are said, by Paracelsus, to indicate active wickedness, with a mind calculated to oppose with vigour, and suffer with perseverance; and their opposites, or very large prominent eyes, he conceived explained the avaricious, covetous, propensities of their possessor; those in constant motion denotes fear and care; winking is the mark of foresight, of an amorous disposition, and quickness in projecting; and the eye fearful of looking directly forward, decides upon innate modesty.

Lavater thought blue eyes, in general, signified effeminacy and weakness, and yet he acknowledged that many eminent men have had blue eyes; still he was convinced that strength and manhood more particularly belong to the brown: in opposition to this opinion, the Chinese, who are known to be an imbecile people, rarely have blue eyes; these contradictions, it must be confessed, weaken the reliance we are inclined to place on appearances during the quiescent state of the eyes, and the indications of their colour. Men intemperate in anger, and easily irritated, may be found with eyes of all the usual colours; when they incline to green, ardour, spirit, and courage, are constant attendants. People of a phlegmatic habit, but who may be roused to activity, have clear blue eyes, which never belong to those inclined to melancholy, and they rarely belong to the choleric. Benevolence, tenderness, timidity, and weakness, are exhibited by the perfectly semicircular arch formed by the under part of the upper eye-lid: persons of acute and solid understandings have a generous open eye, composing a long and acute angle with the nose; and when the eye-lid forms a horizontal line over the pupil, it is a strong indication that he who possesses it is subtile, able, and penetrating. Widely opening lids, shewing the white of the ball under the other colours, may be observed in the phlegmatic and timid, as well as in the courageous and rash; but upon comparing these marks in the different characters just mentioned, a very perceptible difference is discovered in the characteristics of the eyes; the latter are less oblique, better shaped, and more firm.

The eye-brows are essential in the expression of the eyes, in anger they are brought down and contracted; in all pleasant sensations, and in astonishment, they assume a fine arch; in youth they are naturally and regularly arched; the horizontal and rectilinear eye-brow belongs to the masculine bias of the soul; and the above designations combined shew strength of understanding, united with feminine kindness; those that are deranged in their appearance, and the hairs growing in various directions, demonstrate a wild and perplexed state of mind; but if the hair is fine and soft they signify gentle ardour. The compressed firm eye-brow, formed of parallel hairs, is a certain proof of profound wisdom, true perception, and a manly firm habit of thought. There are eye-brows which meet across the nose, this circumstance gives the person an air of ferocious gloom which is admired by the Arabs, but the ancients, versed in physiognomy, conceived such to be characteristic of cunning; Lavater, on the contrary, observes, that he had discovered them on the most worthy and open countenances, admitting at the same time that they may denote a heart ill at ease. Those who think profoundly, and those equally prudent and firm in their conduct, never have high and weak eye-brows, in some measure equally dividing the forehead, they rather betray debility and apathy, and though men of an opposite character may be found with them they invariably signify a diminution of the powers of the mind. Thick angular eye-brows, interrupted in their lengths, signify spirit and activity; and when they approach the eyes closely, the more firm, vigorous, and decided, is the character; the reverse shews a volatile and less enterprizing disposition; when the extremes are remote from each other, the sensations of the possessor are sudden and violent. White eye-brows are demonstrative of weakness, in the same degree that the dark-brown are of firmness.

The good Lavater considered the nose as

the abutment, or buttress, of the forehead, the seat of the brain, without which the whole face would present a miserable appearance; indeed an ugly or disagreeable set of features is never accompanied by a handsome nose: but there are thousands of fine and expressive eyes where a perfectly formed nose is wanting; he describes this portion of the face as requiring the following peculiarities: "Its length should equal the length of the forehead; at the top should be a gentle indenting; viewed in front, the back should be broad, and nearly parallel, yet above the centre something broader; the bottom, or end of the nose, must be neither hard nor fleshy, and its under outline must be remarkably definite, well delineated, neither pointed nor very broad; the sides, seen in front, must be well defined, and the descending nostrils gently shortened; viewed in profile, the bottom of the nose should not have more than one third of its length; the nostrils above must be pointed below, round, and have in general a gentle curve, and be divided into equal parts by the profile of the upper lip; the side, or arch of the nose, must be a kind of oval; above, it must close well with the arch of the eye-bone, and near the eye, must be at least half an inch in breadth. Such a nose is of more worth than a kingdom." Numbers of great and excellent men have flourished in all ages of the world, whose noses would suffer essentially by a comparison with Lavater's description of a nose, more valuable to the possessor than extensive empire; indeed, he is compelled to acknowledge this indisputable fact, and observes that he has seen persons endowed with purity of mind, noble in their conceptions, and capable of exertion, whose noses were small, and the arches of their profiles inverted; and yet true to his first principles, he discovered, or imagined he discovered, their worth to consist chiefly in the elegant effusions of their imaginations, their learning, or fortitude in suffering, and this is accompanied with a proviso that the remainder of their form must be correctly organized.

Noses arched near the forehead belong to those who possess the energy to command, are capable of ruling, acting, overcoming, and destroying; others, rectilinear, are the medium between the extremes above noticed, and are appropriated by nature to persons who act and suffer with equal power and patience. Socrates, Lairasse, and Boerhaave, were great men, and had ill-shaped noses, and were distinguished for meekness and gentleness. Were it possible to attribute a general prevalence of disposition to a general form of the nose, individuals of every nation would be found to resemble the Tartars who have flat indented noses, the Negroes who have broad, and the Jews who have high arched noses, in their propensities, and it must follow that whatever qualities the physiognomist may apply to those individuals, must also belong to the whole people whose noses bear a resemblance to them; were this particular accurately examined into, it would tend, in a great measure, to confirm the correctness or incorrectness of the science, as it has hitherto been practised.

The admirers of this study attribute great powers to the mouth, in expressing the emotions of the mind; and Lavater expatiates on it with enthusiastic fervour indeed: "Whoever," he exclaims, "internally feels the worth of this member, so different from every other member, so inseparable, so not to be defined, so simple, yet so various; whoever, I say, knows and feels this worth will speak and act with divine wisdom." He then proceeds to call it "the chief seat of wisdom and folly, power and debility, virtue and vice, beauty and deformity, of the human mind; the seat of all love, all hatred, all sincerity, all falsehood, all humility, all pride, all dissimulation, and all truth." Granting the benevolent pastor full assent to these observations on the mouth, it becomes the indispensible duty of all men to notice the physiognomy, or indications of that organ; in making those observations it will be necessary to examine the lips separately, and to ascertain when they are closed, during the moments of perfect tranquillity, whether that operation is performed without a forcible exertion of the muscles, particularly the middle of the upper and under lips, the bottom of the middle line at each end; and finally, the extending of the middle line on both sides.

The character of the man is proclaimed in the lips, the more firm the latter the more fixed the former; the weak and irresolute man has weak lips, with rapidity in their motion. The vicious, cringing, mean, and bad countenance is never formed with lips well defined, large, and justly proportioned to the other parts of the face, and the line of which is equally serpentine on each side; such, though they may denote a

tendency to sensuality, belong exclusively to a character deserving of admiration in most relations of life.

A mouth, the lips of which are so thin as to present, at first view, little more than a line, is said to indicate apathy and quiet, but industrious when roused. When this description of mouth is raised at the extremities, vanity or vain pretensions, affectation, and probably deliberate malice, distinguish those so formed. The opposite of this kind of lips, swelled into considerable size, is a mark of indolence and sensuality. The "cut through, sharp drawn lip," as Lavater terms some, has to contend with avarice and anxiety. Lips closed accurately, without exertion, and handsome in their outline, belongs to the exercise of discretion and firmness. Lips with the latter advantage, and the upper projecting, is generally appropriated to the virtuous and benevolent, though there are, without doubt, numberless persons of excellent characters whose under lips project, but in Lavater's opinion, the last peculiarity implies a well meaning man, whose goodness consists rather of cold fidelity than ardent friendship. The under lip, hollowed in the middle, denotes a fanciful character. Let the moment be remarked, when the conceit of the jocular man descends to the lip, and it will be seen to be a little hollow in the middle.

The mouth remaining naturally closed, invariably signifies fortitude and courage. When the latter quality is in operation, the mouth closes insensibly; the naturally open mouth makes a disposition to complain; the closed, on the contrary, designates endurance. "Though physiognomists," adds Lavater, "have as yet but little noticed, yet much might be said concerning the lips improper, or the fleshy covering of the upper teeth, on which anatomists have not, to my knowledge, yet bestowed any name, and which may be called the curtain, or pallium, extending from the beginning of the nose to the red upper lip proper. If the upper lip improper be long, the proper is always short; if it be short and hollow, the proper will be large and curved. Another certain demonstration of the conformity of the human countenance. Hollow upper lips are much less common than flat and perpendicular: the character they denote is equally uncommon."

The ancients who studied the physiognomy of man, supposed that diminutive short teeth betrayed the weakness of those who possessed them; more modern observers contradict this supposition, and declare that men of uncommon strength have such, but they are rarely of that pure white so necessary to preserve the general beauty of the countenance. Teeth of unusual length, and narrow, are signs of weakness and cowardice; those justly proportioned to each other, white and transparent, which appear immediately upon opening of the mouth, though not projecting, and intirely exposed to view from the insertion in the gums to the opposite extremities, are seldom to be met with in the jaws of persons who possess unamiable propensities; when teeth of a different description are discovered belonging to amiable and worthy characters, enquiry will generally satisfy the physiognomist that his conclusions on this head were just, and that the blackness and derangement was occasioned by disease.

In one way the observer and admirer of this art cannot possibly be mistaken, for he that neglects his teeth, suffering them to decay through contempt of public opinion and indolence, may be safely pronounced an unhappy character, with many evil propensities.

The chin alone remains to be noticed in this slight survey of the human face, as connected with the internal operations of the soul or mind. The projecting chin is said to mark something decided, and the receding the reverse; and it has been asserted that the presence or absence of strength is frequently demonstrated by the form of this part of the countenance, it has also been remarked, that sudden indentings in the midst of the chin are peculiar to men of excellent cool understandings, unless attended by marks of a contrary tendency. When the chin is pointed, those so formed are supposed to be penetrating and cunning, though it seems there are people with pointed chins who are different at least in the latter particular; and here again the chin offers a certain criterion for the physiognomist, who may securely pronounce a large fat double chin an appendage of gluttony. "Flatness of chin speaks the cold and dry; smallness, fear; and roundness, with a dimple, benevolence."

After all, it will be admitted, that this science, if such it can fairly be denominated, must be precarious, and, in some respects, delusive. It cannot, however, be doubted, that there is an apparent correspondence between the face and the mind: the features and lineaments of the one are directed by the motions and affections of the

other; there is, perhaps, even a peculiar arrangement of the members of the face, and a peculiar disposition of the countenance to each particular affection of the mind. Some, indeed, have asserted, that the language of the face is as copious, and as distinct and intelligible as that of the tongue: to this, however, we must beg leave to object; it may be as sincere, but certainly not so intelligible. The face has been said to act the part of a dial-plate, and the wheels and springs within the machine actuating its muscles, shew what is next to be expected from the striking part, But if, by repeated acts, or the frequent entertaining of a favourite passion or vice. the face is often put into that posture which attends such acts, it may, in some measure, become fixed, and almost unalterable, in that posture, unless some present object distort it therefrom, or some dissimulation hide it; and hence it has been assumed that much accuracy would enable one to distinguish, not only habits and tempers, but also professions.

We have asserted that all men are involuntarily physiognomists, but the impression made by the first sight of a person, is generally too slight to leave an injurious bias upon the mind of the observer; and it is fortunate for man that this is the case, otherwise prejudices would be generated which might set half the world at variance with the remainder. We have thought it necessary to explain the nature of the science under consideration, but we by no means recommend its study, as nothing can be more dangerous to the existing harmony of society; besides every person is not prepared for this pursuit, which requires a sound judgment, a good education, a perfect knowledge of what human features are in their pristine shape, and of the numerous causes which occasion their derangement. For instance, it is very evident that a peevish habit, and a melancholy countenance, may be produced by a series of misfortunes; besides, the writer of this article has had an opportunity of observing two persons who have been the victims of excessive anxiety, whose faces now possess a character totally foreign to that which they possessed a few years past, one a handsome man with perfectly regular features, passing through the streets under the influence of deep thought and perplexity, suddenly perceived that every object changed its place, in short the eyes were turned inwards towards the nose, in which position they remain, and he will squint, as the term is, to the last moment of his life: a physiognomist, a stranger to this fact, must conceive a very different character of the man from the truth: the other person, enduring the same species of mental perturbation, experienced a slight paralytic affection, and from that moment the right corner of his mouth has been drawn downwards, producing an appearance of immoderate grief, even when the rest of his features are enlivened with pleasure. "No one," says Lavater, "whose person is not well-formed can become a good physiognomist. Those painters were the best whose persons were the handsomest. Reubens, Vandyke, and Raphael, possessing three gradations of beauty, possessed three gradations of the genius of painting. The physiognomists of the greatest symmetry are the best. As the most virtuous can best determine on virtue, so can the most handsome countenances on the goodness, beauty, and noble traits of the human countenance, and consequently on its defects and ignoble properties. The scarcity of human beauty is the reason why physiognomy is so much desired, and finds so many opponents. No person, therefore, ought to enter the sanctuary of physiognomy, who has a debased mind, an ill-formed forehead, a blinking eye, or a distorted mouth. "The light of the body is the eye; if therefore thine eye be single, thy whole body shall be full of light! but if thine eye be evil, thy whole body shall be full of darkness: if therefore that light that is in thee be darkness, how great is that darkness?"

PHYSIOLOGY is, according to the derivation of the term, a discourse on natural bodies: but it formerly denoted only an internal reasoning, which terminates in speculation, or abstract contemplation of its object; namely, natural appearances, their causes, &c.: but the usual acceptation of the word is very different in the present state of science, as we shall see by the following article.

PHYSIOLOGY is the science which treats of the powers that actuate the component parts of living animal bodies, and of the functions which those bodies execute. It presupposes, therefore, a knowledge of the structure of the body, which is the object of anatomy; the latter may be called the science of organization, while physiology is the science of life. The two subjects are so closely connected, that they would be most advantageously considered in connection with each other. Hence the reader will find many physiological considerations under the articles ANATOMY and

COMPARATIVE ANATOMY, which indeed he should peruse as an introduction to the present article.

General View of the Functions exercised by the animal Body.

The term life denotes one of those general and obscure notions produced in our minds by certain series of phenomena, which we have observed to succeed each other in a constant order, and to be connected together by mutual relations. Being ignorant of the bond of union which connects these, although we are convinced of its existence, we have designated the assemblage of phenomena by a name which is often regarded as the sign of a peculiar principle; although it should indicate nothing more than the collection of appearances, which have given rise to its formation. Thus, as our own bodies, and several others, which resemble them more or less strongly in form and structure, appear to resist for a certain time the laws which govern inanimate matter, and even to act on surrounding objects in a manner quite contrary to these laws, we employ the expressions of life and vital power, to designate these at least apparent exceptions to general rules. Our only method of fixing the meaning of these words is, to determine exactly in what these exceptions consist. With this object, let us consider the bodies alluded to in their active and passive relations to the rest of nature. Let us contemplate, for instance, the body of a female in the vigour of youth and beauty: those rounded and voluptuous forms; those graceful and easy motions; those cheeks glowing with the roses of pleasure; those eyes sparkling with the inspirations of genius, or fired by the warmth of love; that physiognomy enlivened by the sallies of wit, or animated by the fire of the passions; all unite to form a truly enchanting object. A single moment is sufficient to destroy this pleasing illusion: sensation and motion often cease on a sudden, without any apparent pre-existing cause; the muscles, losing their plumpness, shrink and expose the angular projections of the bones; the lustre of the eyes is gone, the cheeks and lips grow livid. These are only the prelude to still more unpleasant changes: the flesh turns successively to blue, green, and black; it imbibes the moisture of the atmosphere, and, while one part is evaporated in pestilential emanations, the other melts into a putrid sanies, which also is speedily dissipated. In short, after a few days, nothing remains but a few earthy or saline principles; the other elements having been dispersed in the air, or waters, to form new combinations.

This separation is the natural effect of the action of air, moisture, and heat, that is, of all the surrounding external agents, on the dead body; and it arises from the elective attractions which these agents possess for the materials of the body. Yet it was equally surrounded by them during life: their affinities for its component parts were the same; and the latter would have yielded in the same manner, if they had not been held together by a superior power, the influence of which continues to operate until the moment of death.

This resistance, then, of the laws which act on dead matter, is one of the particular ideas entering into the general notion of life, which seems, in a more especial manner, to constitute its essence; for without it life cannot be conceived to exist, and it continues uninterruptedly until the moment of death.

Almost endless disputes have arisen among physiologists concerning the essential nature of this vital principle. Vitality is one of those attributes which can be more easily discerned and recognized when present in any object, than accurately defined. Definition indeed would be more likely to confuse than to illustrate it. It is manifested most incontestibly by certain effects, referrible to peculiar powers, which are justly called living or vital, because the actions of the living body are so far depending on these powers, that they can, by no means, be explained by the physical, mechanical, or chemical qualities of matter. Yet the operation of the latter can be clearly discerned in many instances in the animal economy; thus the humours of the eye variously affect the rays of light according to their figure and density: and the mechanical elasticity of the epiglottis, and the chemical affinities exercised in respiration, are further examples to the same effect. Yet the energy and power of the vital force is most clearly evinced in resisting and overcoming, as we have already stated, the common laws of matter. Stahl and his followers, were so struck with the circumstance of living bodies resisting those affinities, which produce putrefaction in dead animal matter, that they made life itself to consist in this antiseptic property. The celebrated experiment of Borelli, in which a muscle, deprived of life, was immediately torn by a weight which it

could lift easily during life, shows how the laws of gravity are overcome. This vital power, in the explanation and illustration of which all physiology is concerned, is so apparent in every living process, that it has been observed by the physiologists of every age, although designated by very various appellations, and defined in very different ways. Calidum innatum, archæus, spiritus vitalis, principium sentiens, &c. are among its numerous appellations. Let it be remembered, that neither these, nor the phrases of vital principle, &c. express any being existing by itself, and independently of the actions by which it is manifested; they are only to be considered as denoting the assemblage of powers that animate living bodies, and distinguish them from inert matter. Some writers, realizing the offspring of a mere abstraction, have talked of the living principle as something distinct from the body, to which they have ascribed powers of seeing and feeling, and even of acting with design.

A more close inspection of any living body will speedily convince us, that this force, which holds together its component parts, in spite of the external powers, which tend to separate them, does not confine its influence to this passive result, but that its operation extends even beyond the limits of the living body itself. It seems, at least, that this power does not differ from that by which new particles are attracted, and interposed between the old constituent ingredients of the body; the latter effect seeming to be exerted as constantly as the power by which the materials of the body are held together. For, besides the absorption of alimentary matter from the intestines, and its entrance into the circulating fluid, carrying it to all parts, which processes experience no interruption, but are continued from one meal to another, there is another kind of absorption constantly going on from the surface of the body, and a third which takes place by means of respiration. The two latter alone exist in such living bodies as have not the function of digestion; viz. in plants. Now, since living bodies do not grow indefinitely, but have certain limits assigned by nature to their size; they must lose on one side, at least, a large part of what they receive on the other; and, in fact, attentive observation shows us, that perspiration, and several other processes, are constantly destroying parts of their substance.

Hence the idea which we formed at first of the principal phenomenon of life, must be considerably modified. Instead of a constant union of the composing particles, we observe them in a state of continual circulation from without inwards, and from within outwards. Thus, a living body is a structure into which dead particles are successively brought, for the purpose of combining together in various ways, occupying places and exercising offices determined by the nature of the combinations into which they enter, and departing, after a certain period, to be brought under the action of those laws which regulate inanimate matter. We must observe, however, that the proportion of particles, entering into or quitting the system, varies according to the age and health of the individual, and that the velocity of the general motion differs according to the different states of each living body.

It appears, too, that life is arrested by causes similar to those which interrupt other known kinds of motion; and that the induration of fibres, and obstruction of vessels, would render death an inevitable consequence of life, as rest necessarily follows all movements which are not performed in vacuo, even if the hour of its approach were not hastened by a multitude of extraneous causes.

This general and common motion of all parts constitutes the very essence of life, insomuch that parts separated from a living body immediately die, because they have no power of motion within themselves, and only participate in the general motion produced by the assemblage. Thus, the peculiar mode of existence of any part of a living body arises from the whole; while, in dead matter, each particle has it within itself.

When this nature of life was once clearly recognised by the most constant of its effects, physiologists naturally attempted to discover its origin, and the mode of its communication to bodies which it animates. They looked at them in their earliest state, approaching as nearly as possible to the instant of their formation; but they could only discover them completely formed, and already possessing that circulatory motion, of which they were investigating the first cause. However delicate the parts of a fœtus, or a vegetable, in the first moments that we can perceive them, they still possess life, and have within themselves the germ of all the phenomena which this life will develope in the sequel. These observations having been repeated in every class of living bodies, have led to the general

conclusion, that there is none which has not formerly constituted part of a body like itself, from which it has been detached; all have participated of the life of another body, before the vital motions were carried on independently in themselves; and it is, indeed, through the means of the vital powers, inherent in the bodies of which they formed part, that they have been so far developed as to become susceptible of an isolated life. For although copulation is necessary in the act of reproduction in several species, it is by no means an essential circumstance, and does not, therefore, change the nature of generation. In reality, then, the peculiar powers of living bodies have their origin in those of the parents; this is the source of the vital impulse, and, consequently, it follows, that life is only produced from life, and that no other exists, except what has been transmitted from living bodies to living bodies, in an uninterrupted succession.

Since we cannot go back to the first origin of living bodies, our only resource in investigating the true nature of the powers which animate them consists in examining their structure, and tracing the union of their elements. Our knowledge of these points is too imperfect for us to draw all the necessary inferences. The minute branches of vessels and nerves, and the intimate structure of the organs in general, elude our imperfect means of research: our analysis of fluids is also very incomplete, and there are, probably, several which we have no means at all of subjecting to examination. Yet, though our knowledge of organization be not sufficient to enable us to explain all the facts presented to our observation by living bodies, we may, by means of it, recognise them, even in an inactive state, and trace their remains after death. No inanimate matter has that fibrous and cellular texture, nor that multiplicity of volatile elements which form the characters of living bodies, whether alive or dead. Thus, while inorganic solids are only composed of many-sided particles, attracting each other by their surfaces, and receding only for the purpose of separating; while they are resolved into a very limited number of elementary substances, and are formed merely by the combination of these elements, and the aggregation of these particles; while they grow only by the juxtaposition of new particles, which are deposited exteriorly to those already existing, and are destroyed only by the mechanical separation of their parts, or the decomposing agency of chemical means; organized bodies, made up of fibres and laminæ, whose intervals are filled by fluids, are resolved almost entirely into volatile elements, grow on bodies similar to themselves, and separate from these only when they are sufficiently developed to act by their own powers; constantly assimilate foreign matters to themselves, and, interposing these between their own particles, grow by the operation of an internal power, and perish at last by this interior principle, indeed, by the very effect of their life.

An origin by generation, a growth by nutrition, and a termination by death, are the general characters common to all organised bodies; and if several of such bodies possess these functions only, and such as immediately depend on them, and have only the organs required for their performance, there are many others exercising particular functions which require appropriate organs, and also modify the general functions and their organs.

Of all the less general powers, which presuppose organization, but which do not seem to be necessary results of structure, those of sensation and voluntary motion are the most remarkable, and exert the greatest influence over the other functions. We are conscious of the existence of these powers in ourselves, and we attribute them, by an analogical mode of reasoning, to many other beings, which we therefore name animated beings, or animals. They seem to be necessarily connected together; for the idea of voluntary motion contains in itself that of sensation; since volition cannot be conceived without desire, and without a feeling of pleasure or pain. The goodness, which we observe in all the works of nature, will not allow us to believe that she has formed beings with the power of sensation, that is, with a susceptibility of pleasure and pain, without enabling them at the same time to approach to the one and fly from the other, at least to a certain degree. And, if, among the too real misfortunes which afflict our species, one of the most affecting is the sight of a man of sensibility deprived by superior force of the power of resisting oppression; the poetic fictions, most apt to excite our pity, are those which represent sensible beings inclosed in immoveable bodies; and the tears of Clorinda, flowing with her blood from the trunk of a cypress, ought to arrest the blows of the most savage man.

Independently of the chain, which unites these two powers, and of the double apparatus of organs which they require, they produce also several modifications in the faculties common to all organised bodies; and these modifications, joined to the two peculiar powers, constitute more particularly the essential nature of animals. Thus, in respect to nutrition, vegetables being attached to the earth, absorb nutritive fluids directly by their roots; these almost infinitely subdivided, penetrate the smallest intervals of the soil, and, if we may use the expression, travel to a distance in quest of nourishment for the plant to which they belong; their action is quiet and constant, being liable to interruption only when drought deprives them of the necessary juices. Animals on the contrary, fixed to no spot, but frequently changing their abode, required the power of transporting with them the provision of fluids necessary for their nutrition; they have therefore an interior cavity to receive their food; and on its inner surface there are the openings of absorbing vessels, which, to use the energetic language of Boerhaave, are real internal roots. The size of this cavity, and of its orifices allowed in several animals the introduction of solid substances. These required instruments for their division, and liquors for their solution; in a word, nutrition was no longer performed by the immediate absorption of matters in the state in which the earth or atmosphere furnished them; it was necessarily preceded by various preparatory operations, which, taken altogether, constitute digestion.

Thus digestion is a function of a secondary class, peculiar to animals. Its existence, as well as that of the alimentary cavity in which it takes place, is rendered necessary by the power which animals have of voluntary motion; but it is not the only consequence of that power.

Vegetables, having few faculties, are simple in their organization; being composed almost entirely of parallel or slightly diverging fibres. Moreover, their fixed position admitted of the general motion of their nutritive fluid being kept up by simple external agents; thus it ascends by means of suction in their spongy or capillary texture, and also through the influence of evaporation, from the surface; it is rapid in a direct ratio to this evaporation, and may even become retrograde when that process ceases, or when it is changed into absorption by the moisture of the atmosphere.

It was necessary that animals should have within themselves an active principle of motion for their nutritive fluid, not only because they were destined to constant changes of situation and temperature; but also from their more numerous and highly developed faculties requiring a much greater complication of organs. Hence the component parts became very intricate in their composition, and often very distant, and possessed in many instances a power of changing their relative position; consequently the means of carrying the nutritive fluid through such multiplied intricacies must be more powerful than in vegetables, and differently arranged. It is contained, in most animals, in innumerable canals, which branch out from two trunks, that communicate together in such a way, that the fluid urged into the branches of one is received by the roots of the other, and carried back to a common centre, from which it is propelled a fresh.

At the point of communication between the two great trunks is placed the heart, whose contractions impel the nutritive fluid into all the branches of the arterial trunk; for the orifices of the heart possess valves disposed in such a way that the circulating juices can only move in the directions now described, *viz.* from the heart towards all parts by the arteries, and from all parts to the heart in the veins.

In this rotatory motion consists the circulation of the blood, which is another secondary function peculiar to animals, chiefly performed and regulated by the heart. This, however, is not so essentially connected to the faculties of sensation and motion as the business of digestion; for whole classes of animals (as insects) possess no circulation, and are nourished, like vegetables, by the mere imbibing of fluids prepared in the intestinal canal.

The blood seems to be merely a vehicle, receiving constantly from the intestines, skin, and lungs, different substances, which it incorporates intimately, and by which its losses arising from the preservation and growth of parts, are supplied. The nutrition of the body is performed during the course of the blood in the minute extremities of the arteries; here the fluid changes its nature and colour; and it is only by the addition of the various substances just pointed out, that the venous blood again becomes proper for the purposes of nutrition, or, in one word, again becomes arterial.

The venous blood receives the supplies

furnished to it by the skin and alimentary canal, by a particular set of vessels, called lymphatics; in the same way it receives also the particles detached from various organs, in order to be sent out of the body by the different secretions.

The air entering the lungs seems to produce a sort of combustion in the venous blood, which is necessary for the support of life in all organized bodies. Vegetables, and such animals as have no circulation, respire (for that is the name given to this action of the atmosphere on the nutritive fluid) by their whole surface, or by means of particular vessels which convey air into the interior of the body. Those only, which enjoy " true circulation, breathe by means of a particular organ; because, in them, the blood constantly flowing to and from a common source, its vessels have been so arranged, that it is not distributed to the other parts of the body until after passing through the lungs; a circumstance which could not take place where the nutritive fluid is distributed uniformly through the body without being contained in vessels. Thus respiration is a function of a third order, depending entirely on circulation, and arising as a remote consequence from the faculties which characterise animals.

Generation is the only process in animals, the mode of which does not depend on their peculiar faculties, at least as far as the fecundation of the germs is concerned. Their power of moving and approaching to each other, of desiring and feeling, has allowed them to receive all the enjoyments of love, while the spermatic fluid is conveyed uncovered immediately upon the germs; in vegetables, on the contrary, which have no power of propelling this fluid, it is inclosed in small capsules capable of being transported by the wind, and forming what is called the dust of the stamina. Thus, while the organs of the other functions are more complicated in animals, on account of their peculiar functions, generation is exercised in them, for the very same reason, in a more simple way than in vegetables.

Such are the principal functions that compose the animal economy; they have usually been arranged in three orders. Some of them constitute animals what they are, render them proper to fill the space which nature has marked out for them in the general arrangement of the universe, and would be sufficient for their existence, if that were momentary. These are the faculties of sensation and motion; of which the former determines them in the choice of such actions as they are capable of, and the latter enables them to execute these actions. Each animal may then be considered as a partial machine, co-ordinate to all the other machines, which, by their assemblage, from this world: the organs of motion are the wheels and levers: in a word, all the passive parts; but the active principle, the spring which sets all in motion, resides only in the sensitive faculty, without which the animal would be lost in a constant sleep, and be really reduced to a merely vegetative life. These two functions, then, form the first order, or the animal functions.

But the animal machine, in addition to the powers which those of human construction possess, is endowed with a principle of preservation and repair, consisting in the assemblage of functions which contribute to nutrition, viz. digestion, absorption, circulation, respiration, and secretion; these form the second order, or the vital functions. Lastly, as the duration of each animal is limited according to its species, the generative form a third order of functions, by means of which the individuals that perish are replaced, and the existence of the species preserved.

This threefold division of the objects of physiology is open to many objections, which we have not room to consider in this place; and we therefore add another more complete and natural classification, which will be sufficiently explained in the subjoined tabular view.

PHYSIOLOGY.

CLASSIFICATION OF FUNCTIONS.

- **CLASS I.** FUNCTIONS CONTRIBUTING TO THE PRESERVATION OF THE INDIVIDUAL..... *(Individual life.)*
  - **FIRST ORDER.** By assimilating alimentary matters to his own substance......... *(Assimilating, internal, or nutritive functions.)*
    - **GENUS I. DIGESTION.** Extracts from it the nutritive parts.......
      - Prehension of food.
      - Mastication.
      - Salivary secretion.
      - Deglutition.
      - Digestion.
      - Chylification.
      - Excretion of feces and urine.
    - **II. ABSORPTION.** Carries it into the circulating fluid........
      - Absorption of chyle.
      - ———— lymph.
      - Action of vessels.
      - ———— glands.
      - ———— thoracic duct.
    - **III. CIRCULATION.** Conveys it to all the organs ....
      - Action of the heart.
      - ———— arteries.
      - ———— capillary vessels.
      - ———— veins.
    - **IV. RESPIRATION.** Combines it with the oxygen of the atmosphere...........
      - Action of the parietes of the thorax.
      - ———— lungs.
      - Changes in the air.
      - ———— blood.
      - Animal heat.
    - **V. SECRETION.** Makes it undergo various modifications.
      - Transudation of serum.
      - Mucous secretion.
      - Action of glands.
    - **VI. NUTRITION.** Applies it to the organs for the purposes of growth and repair...........
      - Differing in every part according to its peculiar composition.
  - **SECOND ORDER.** By establishing his relations to surrounding beings.............. *(External, or relative functions.)*
    - **GENUS I. SENSATIONS** Inform him of their presence.............
      - Organs
        - Of sight.
        - — hearing.
        - — smelling.
        - — tasting.
        - — touching.
      - Action of the nerves.
      - ———— brain.
      - Human understanding.
      - Perception.
      - Memory.
      - Judgment.
      - Volition.
      - Sleeping and waking.
      - Dreams.
      - Somnambulism.
    - **II. MOTIONS.** Enable him to approach to or avoid them.................
      - Muscular organs and action.
      - Skeleton.
      - Articulations.
      - Standing.
      - Progressive motions.
      - Motions of the upper extremities.
    - **III. VOICE & SPEECH** Give him the power of communicating with his species, without change of situation............
      - The voice
        - articulated; or speech:
        - modulated; or singing.
      - Stammering.
      - Lisping.
      - Dumbness.
      - Ventriloquism.

CLASS II. FUNCTIONS CONTRIBUTING TO THE PRESERVATION OF THE SPECIES.......... *(Life of the Species.)*	FIRST ORDER. Whether they require the co-operation of both sexes......	CONCEPTION.......... GENERATION..........	General differences of sex. Hermaphrodites. Systems of generation.
	SECOND ORDER. Or belong exclusively to the female............	GESTATION............	Pregnant uterus. History of the embryo. ——— fetus. ——— coverings of the fetus.
		PARTURITION.........	State of the uterus after parturition. Lochia.
		SUCKLING..............	Action of the breasts. Milk.
		GROWTH OF THE BODY.................	Infancy—Dentition—Ossification. Puberty—Menstruation.
		MANHOOD. Temperaments	Sanguineous. Choleric. Melancholic. Phlegmatic.
		MANHOOD. Idio-syncrasies.	
		MANHOOD. Races of mankind..........	Caucasian. Negro. Mongul. Malay. American.
		DECLINE OF THE BODY..................	Age of decrease. Old age. Decrepitude.
		DEATH.	
		PUTREFACTION.	

To trace out completely all the subjects which this table exhibits, would lead into a very wide field of discussion; we shall, after devoting a short space to the consideration of those vital powers which animate living bodies, shortly consider the principal functions.

Of the Vital Powers, Sensibility and Contractility.

Struck with the numerous differences that are observable between organized and living, and inorganic matters, philosophers have admitted in the former a peculiar principle of action, a force which maintains the harmony of their functions, and directs them all to one object; the preservation of the individual and of the species. No one at present doubts the existence of a living principle, which subjects the beings endued with it to a different order of laws from those which govern inanimate things, and whose principal effects are seen, in its removing the bodies which it animates from the agency of chemical affinities, to which the multiplicity of their elements would otherwise have rendered them prone; and in its maintaining their temperature at an uniform standard. All the phenomena observed in the living animal body might be cited in proof of this principle. The effects produced on the food by the digestive organs; its absorption by the lacteals; the circulation of the nutritive juices in the blood-vessels; the changes which they undergo in the lungs and secretory glands; the capability of receiving impressions from external objects, and the power of approaching to, or avoiding them, all demonstrate its existence. But we prove it more directly by means of the two properties, with which the organs of these functions are endued. These are sensibility, or the faculty of feeling; the aptness to receive, from the contact of foreign bodies, more or less vivid impressions, which change the order of their motions, accelerate or retards suspend or terminate, them; and contractility, by which parts, when irritated, contract, act, or execute motions.

By means of the senses, and of the nerves which are continued from them to the brain, we perceive or feel the impression, made on our bodies by external objects.

The brain which is the true seat of this relative sensibility (or, as it might well be called, perceptibility), being excited by these impressions, influences the moving powers of the muscles, and determines the exercise of their contractility. This property, subjected to the command of the will, is manifested by the sudden shortening of the muscular organ, which swells, becomes hard, and causes those parts of the skeleton to which it is attached to move. The nerves and the brain are the essential organs of these two properties; division of the former destroys sensation, and the voluntary motion of those parts to which the nerves are distributed. But there is another kind of sensibility quite independent of the presence of nerves, existing in all organs, even where no nervous filaments are distributed. Bones, cartilages, ligaments, arteries, and veins, in short, all parts which are not influenced by the will, possess no nerves. Yet, though in their natural state they transmit to the brain no perceptible impression, though they may be injured without giving the animal any pain, and though the will has no influence over them, yet they enjoy a sensibility and contractility, by virtue of which they perceive impressions, and contract in their own manner, recognize in the fluids which circulate through them what is proper for their nutrition, and, separating this part, appropriate it to their own substance.

We recognize then in the parts of our body two modes of sensation, as well as two species of motion: a sensibility, by means of which certain parts transmit to the brain, impressions which they feel, and of which we therefore become conscious: a second kind, pervading every part without exception, and presiding over the assimilating functions. We observe also two kinds of contractility corresponding to the differences of sensibility: the one by which the voluntary muscles perform the contractions determined by the action of the will; the other manifested by actions which are equally unknown as the causes which give rise to them.

When we have once clearly distinguished these two grand modifications of sensibility and contractility, we shall find out, without difficulty, the source of those eternal disputes, raised by Haller and his followers, concerning the irritable and sensible nature of parts. Bones, tendons, cartilages, &c. to which this great physiologist denied these two properties, enjoy only that *lateral* sensibility and obscure contractility which are common to all living beings, and without which we cannot conceive the existence of life. In the healthy state they are completely destitute of the power of transmitting perceptible impressions to the brain, or of being influenced by that organ to any manifest motion. It has also been disputed whether sensibility and contractility depended on the existence of nerves; whether these were its necessary instruments, and whether their injuries were followed by a loss of those vital powers in the parts which have nerves. We may answer in the affirmative, as far as regards perceptive sensibility, and voluntary motion, which is entirely subordinate to it; but in the negative with respect to the sensibility and contractility which are indispensable in the processes of assimilation.

Sensibility may then be either perceptive or latent. The former is attended with a conscience of the impressions or perceptibility, and requires a peculiar apparatus. The latter, unaccompanied by consciousness, is common to every thing that lives; it has no particular organs, but is universally expanded in all living parts, whether of vegetables or animals. Contractility may be either voluntary and sensible (*vis nervosa*), which is subordinate to perceptibility; involuntary and insensible, which corresponds to latent sensibility; or involuntary and sensible (*vis insita*), as in the action of the heart, stomach, &c.

The former species of sensibility being that which is observed in the functions, which connect the animal with external objects, is called by Bichat, animal sensibility; and the corresponding contractility is distinguished by the same term. The other kind of these two vital powers, which are exerted in the internal processes of nutrition, &c. common to animals and plants, that is, to all organized bodies, is named the organic.

Organic sensibility is merely the faculty of receiving an impression; animal sensibility is the same faculty, with the additional power of conveying it to a common centre. In the former case the effect terminates in the organ. The latter belongs only to animals, whose perfection is in a direct ratio to the quantity of this sensibility. There is some reason for supposing that these two are not different powers, but that they differ only in quantity. For

inflammation, which is an increased action of parts, raises organic into animal sensibility in diseases of bones, &c.

Different stimuli, applied to the same organ, determine the developement of one or other of these powers: thus no sensation is transmitted to the brain from the passage of blood in the arteries, but when an extraneous fluid is injected, the animal's cries shew that he feels it. The coats of the stomach experience in the healthy state no perceptible impression from the food, but very distinct and even painful sensations are transmitted to the brain when a few grains of poisonous matter are mingled with the aliment. The animal sensibility excited on mucous membranes by foreign bodies (as bougies in the urethra, &c.) is quickly lost, and subsides into organic.

Each organ seems to have, independently of accidental variations, an original quantity or dose of sensibility, to which it returns after any deviation. In this consists the peculiar life of each organ, and from this arise the relations which it has to extraneous substances. Hence excretory ducts, opening on mucous membranes, refuse admission to the substances passing along those canals. Hence the lacteals absorb the chyle only. These particular relations may also take place with matters foreign to the body, as well as with animal fluids, as we see in the case of medicines acting on particular organs, as cantharides, mercury, &c.

Contraction is the common, but not the universal mode of animal motions. For the iris, corpus cavernosum, &c. dilate when they move. Organic contractility is always and immediately connected with organic sensibility, for there is no intermediate function between these; the organ itself is the point in which the sensation ends, and from which the principle of contraction begins. The animal sensibility and contractility are not so closely united; we may feel without moving: here the nerves and brain perform their functions between the action of the two powers.

Sensible organic, or, in other words, involuntary and sensible contractility, corresponds very nearly to irritability; while the insensible seems more like tenacity. To consider irritability as the exclusive endowment of muscles, is taking a very contracted view of the subject. These organs have indeed the largest portion, but every part possessing life reacts, although less manifestly, on the application of certain stimuli. No rule is more fallacious than that of estimating the muscularity of a part by the action of artificial irritants. The organic and animal contractilities cannot be converted into each other as the corresponding sensibilities can.

The parts of the living body possess also some powers which result merely from their organization, and have been denoted by physiologists under the epithet of *vis mortua*. Thus they admit of extension beyond the natural state from extraneous impulse, and of contraction when that impulse ceases to operate. This extensility and contractility are independent of life, and are terminated only by death. The stretching of muscles by moving a limb, the extension of the skin over a tumour, its retraction when divided, &c. are examples of these powers. They have been confounded by some physiologists with the insensible organic contractility.

A muscle exhibits all the powers now enumerated. It contracts, in obedience to the will, by its animal contractility; from the application of stimuli, by its organic sensible contractility. Its nutrition and growth show the existence of organic insensible contractility; and its retraction on a section exemplifies the contractility of organization. The internal organs of the body have only the three last powers, and the white organs (cartilage, tendon, ligament, &c.) only the two last. While, therefore, the two first properties exist only in certain parts, the latter are found in all. Hence the organic insensible contractility may be selected as the general character of all living parts; and the contractility of organization as the common attribute of all living or dead parts that are organically constructed.

As for porosity, divisibility, elasticity, and the other properties which living bodies have in common with inanimate matter; they hardly deserve mention here, because they are never exerted in their whole extent, or in their genuine purity, if we may use that phrase. Their results are always affected by the influence of the vital powers, which constantly modify those effects which seem to flow most directly from physical, mechanical, or chemical causes.

Digestion. Is a function common to all animals, by which foreign substances, introduced into their bodies, and submitted to the action of certain organs, change their

qualities and form a new compound, fit for the purposes of nourishment and growth. Animals alone are provided with digestive organs; all, from man to the polype, have an alimentary cavity, and its existence is, therefore, an essential character of animals. The loss which the body sustains in performing the various actions that take place in the living animal machine is supplied by means of the food. Hunger and thirst admonish us of the wants of our frame, and the pleasures of the palate are a no less strong inducement to the procuring and taking of food.

The cause of hunger has been placed in the mutual attrition of the rugæ of the empty stomach; in the irritation produced by the gastric juice, &c. Perhaps it may be derived more justly from a sympathy between the stomach and the body at large. For when, in diseases of the pylorus, the food cannot be transmitted into the intestines, and does not therefore enter the system, great hunger is experienced, even although the stomach may be filled. Much depends on habit, and on the operations of mental causes: hunger is felt at the usual periods of our repasts; and, if it be not then removed by eating, will often cease spontaneously. The man of letters, absorbed in meditation, often forgets the natural wants of his body. Whatever diminishes the sensibility of the stomach makes hunger more tolerable. Thus, the Indian and Turkish fanatics (Mollahs and Fakirs) are said to support their long fasts by the habitual use of opium. Thirst seems to consist more in a very troublesome dryness of the fauces and œsophagus, and in a peculiar irritation of these parts from the admixture of acrid, and particularly saline matters with the food. The necessity of obeying both these calls varies according to the age, constitution, and particularly the habits of individuals: yet we may state, on the whole, that a healthy adult could not abstain from food for a whole day without bringing on considerable weakness; and that this abstinence could not be continued to the eighth day without the most imminent risk of life. Continued abstinence diminishes the weight of the body to a degree which becomes sensible in twenty-four hours, causes absorption of fat, great prostration of strength, increased sensibility with watchfulness, and a most painful dragging at the epigastric region. Hunger is more speedily fatal in proportion to the youth and strength of the individual. Thus, the wretched father whose dreadful history is immortalised by Dante, shut with his children in a dungeon, perished last, on the eighth day of confinement, after witnessing the death of his four sons, amid the convulsions of rage and cries of despair. We meet with a large collection of examples of long abstinence in the great work of Haller; but they do not seem to possess, in every instance, the requisite authenticity. Many of the subjects were weak and delicate women, living in a state of almost complete inaction, where the powers of life, almost extinct, were only evinced by a very low pulse and respiration repeated at long intervals. They might be compared to hybernating animals, where the waste, occasioned by the functions of active life, does not take place, and where consequently the usual supplies cannot be needed. Although the admonitions of thirst are very imperious, yet drink does not seem so necessary to life and health as solid food. The mouse, quail, parrot, and several other warm-blooded animals never drink, and instances have been known in the human subject. Thirst always becomes greater when any watery secretions are much augmented, as in dropsy, and particularly in diabetes.

In the dispute, whether man be naturally carnivorous or herbivorous, we are inclined to suppose that truth lies on neither side. That the structure both of the teeth and intestines, as well as of the joint of the lower jaw, occupies a middle place between the two just mentioned, and constitutes him an omnivorous animal. This, indeed, seems to follow necessarily from the unlimited extent of his habitation; he can dwell in every country and climate of the globe; and makes use, in various situations, of every variety of alimentary matter, furnished by the animal and vegetable kingdoms.

The food of man, and probably of every animal, is derived from organized matter. Nothing seems capable of furnishing nourishment that has not lived: the mineral kingdom, indeed, supplies some articles of seasoning, which are mixed with our food, and various medicines and poisons, which do not seem to be nutritious.

As man on the one hand is a most truly omnivorous animal, and capable of converting into nourishment almost every production of the animal and vegetable kingdoms, so on the other side he may continue strong and healthy although using one, and that a very simple kind of aliment. A woman, whose case is related in the memoirs of the Medical Society of Edinburgh, lived on whey for

fifty years. Many men live only on certain vegetables, as potatoes, chesnuts, dates, &c. Some wandering Moors, according to Adamson, live almost entirely on gum Senegal. Fish is the only food of numerous uncivilized tribes on different coasts: and flesh of others. Some barbarous hordes still eat raw meat, and even the human body sometimes serves them as a repast. In several islands between the tropics, particularly in the South Sea, there is no fresh water, and the milk of the cocoa-nut is used instead: various other singular facts relating to the food and drink of man might be collected here, showing very clearly that he is an omnivorous animal.

Whatever be the diversity of food, the action of our organs always separates the same nutritive principle from it: in fact, let the diet be totally vegetable, or totally animal, the peculiar composition of our organs does not alter, an evident proof that the matter we extract from aliment to appropriate to ourselves is always alike.

It has been a matter of dispute whether pure water furnish any nourishment, or be a mere diluent.

We have nothing further to say concerning the processes of mastication and deglutition, than what the reader will find in the article Anatomy, under the head of "Organs of Mastication and Deglutition."

Salivary Secretion. This has been estimated by Nuck at the quantity of one pint in twenty-four hours. Although it probably goes on to a certain degree at all times, yet it is more copious when we take food; and the augmentation of quantity arises partly from stimulus, partly from mechanical pressure. When any acrid matter is taken into the mouth, an increased flow of saliva is produced; and this may also follow the mere sight of food, and hence has arisen the well-known expression of the "mouth watering."

All the salivary glands are so situated that the motions of the jaw, and other instruments of mastication, necessarily subjects them to considerable pressure, by which their secretory tubes are evacuated, and new secretion promoted.

The saliva is conveyed into the mouth by the contractile power of the salivary ducts, which, in some rare instances, are said to have projected it even from the cavity of the mouth. The great number of vessels and nerves which belong to, and are placed near these glands, correspond to the copious supplies of fluid which they furnish.

Besides the simple water furnished by the true salivary glands; the mucous follicles, which abound on the surface of the mouth, supply a considerable proportion of that fluid to be mixed with the food. These additions being, by means of mastication, intimately blended with the food, not only reduce it to a soft pultaceous mass, more fit for the process of deglutition, but also bring it into a state of convenient preparation for the subsequent process of digestion and assimilation. In this point of view mastication is very important, as we may observe from the ill effects which ensue when the loss of the teeth renders it imperfect in old persons.

For the chemical analysis of Saliva, the reader will look to that word; and for an account of the digestive process itself, to the article Dietetics; in which are also several observations respecting food.

While the dissolution of the food, produced by the solvent action of the gastric juice, is going on, the two orifices of the stomach remain accurately closed. No gas ascends through the œsophagus, except when the digestive process is imperfect. Soon the muscular fibres of the organ begin to act: the circular ones, contracting at first in a vague and oscillatory manner, soon act more uniformly from above downwards, and from right to left; that is, from the œsophagus to the pylorus; while the longitudinal part approximates the two openings. The pylorus seems to possess a peculiar and exquisite sensibility, by which it distinguishes whether the substances brought in contact with it have been sufficiently acted on by the gastric juice; if that is the case, it releases and allows them to pass, while it remains closely contracted against those which are not thoroughly digested.

The time occupied by the digestive process must be expected to vary according to the constitution, age, and health of the individual, and the nature of the aliment; but it may be stated, in general, at four hours.

The action of the stomach is sometimes inverted, and the contractions, which in that case are forcible, rapid, and convulsive, cause vomiting. The exertions of the respiratory muscles are, however, necessary to the production of this effect.

Although the stomach belongs to those organs whose action is independent of the will, and goes on therefore without the attraction of the individual, yet it is so far influenced by the brain, that the section of

its nerves entirely obstructs digestion. It sympathises most remarkably both with the constitution at large, and with particular organs.

The chyme, or semifluid substance, into which the action of the stomach reduces the food, is propelled by the muscular power of that bag into the duodenum, where it undergoes new changes, particularly from the admixture of other animal fluids, the bile and pancreatic juice: and this process is termed chylification.

The secretion of the pancreas seems to bear a considerable analogy, both in its nature and office, to the saliva and gastric juice. It is very difficult to procure it in a pure and unmixed state from a healthy animal, but the facts which we hitherto possess, shew that its properties are very like those of saliva. It is poured into the duodenum by the contractile power of the pancreatic duct: and its secretion, like that of the salivary glands, is said to be promoted by the pressure of the stomach in its filled state; and by the stimulus of the chyme and bile on the orifice of its duct.

The bile is the fluid furnished by the liver, the largest viscus of the human body, whose importance in the animal economy is evinced by its large apparatus and complicated distribution of blood-vessels, as well as by its constantly existing in all animals which have a heart.

The source of the bile has been questioned, whether it be secreted from the hepatic artery, or vena portarum? The analogy of other secretions, which are all made from arteries, favours the former opinion; but the blood of the vena portarum seems to be the fittest, from its nature, for the secretion of bile. The hepatic artery probably serves to nourish the liver, as the lungs are nourished by the bronchial artery. The distribution of the vena portarum is like that of an artery. If we suppose the hepatic artery to furnish the bile, the excretory duct would be disproportionately large,

The bile, when secreted, passes by a slow but constant stream through the hepatic duct; but a greater or less portion is conveyed by the cystic duct into the gall-bladder, in which it is accumulated, as in a reservoir, and undergoes certain changes of properties, which make it cystic bile. The biliary fluid probably flows directly into the intestine, while the assimilation of the food is going on; and, when the empty state of the duodenum causes the end of the ductus communis choledochus to be compressed by its muscular coat, it regurgitates into the gall-bladder.

There is no direct communication between the liver and gall-bladder, and consequently no other way for the bile to enter that bag, except by the cystic duct. The hepatic bile is a thin fluid, of a clear orange colour, and slightly bitter; the cystic is viscid and tenacious, intensely bitter, and very dark coloured. The bile, thus changed by its residence in the gall-bladder, is expelled by the contractile powers of the gall-bladder and cystic duct into the ductus communis, and thence passes to the duodenum. This bladder absorbs the watery parts of the hepatic bile, and adds a mucous secretion to it.

The chemical analysis, and the uses of the bile are considered under that article.

Function of the Spleen. The situation and attachments of this organ lead us to suppose that its uses are in some way connected with the functions of the stomach; yet there is nothing more than conjecture to be offered on this subject. The removal of the part has been performed in dogs without any material injury to the animal. Its size differs according to the quantity of blood contained in its cells. Physiologists have stated, that its blood possesses peculiar properties; that it is more fluid, does not coagulate, nor separate readily into serum and crassamentum; is more livid, and possesses a greater quantity of carbon. As this blood goes to the liver, and as the part possesses no excretory duct, it has been argued that its function is subservient to that of the liver, in imparting to the blood those properties which fit it for the secretion of bile.

By others, the spleen has been regarded as a sponge, swelling with blood when the stomach is empty, and squeezed out by the pressure of the stomach when that organ is full. Thus, it is said, more blood will go into the stomachic arteries when the secretion of the gastric juice is going on, and the superfluous part in the inactive state of the stomach will distend the spleen.

Action of the small Intestines. The chyle, formed in the duodenum, passes through the tube of the small intestine, which is the organ for absorbing its nutritive parts. The description of this fluid will be found under the article CHYLE. Its progress through the intestine is retarded by the numerous convolutions of the tube; and the chyle, separated from the excrementitious part of the food, is brought into contact with the inhaling orifices of the lacteals, that com-

quence, according to Lieberkühn and other microscopical observers, by patulous orifices on the surface of the villi. The latter projections, so named from a comparison with the pill of velvet, are very numerous on the circular projecting folds of the internal coat, called valvulæ conniventes. These latter not only render the progress of the chyle slower, but increase very greatly the absorbing surface, and penetrate, in consequence of the intestinal contractions, into the midst of the chyle in quest of its nutritive particles. A fluid is secreted from the intestine, analogous to that furnished by the stomach, although an accurate examination of its nature and properties is one of the physiological desiderata, (succus intestinalis). At the same time that the absorption of the chyle from the villous surface of the intestine is going on, it is moved gradually downwards towards the large intestine by the peristaltic motion. This is an undulatory and gentle constriction, taking place in several parts of the tube at once, and producing therefore a singular appearance, compared to the crawling of worms, and hence termed vermicular. It moves the chyle repeatedly over the surface of the intestine; and though it must urge that fluid partially upwards, yet its chief effect in the healthy state is exerted in the opposite direction. It is chiefly in disease that an antiperistaltic movement occurs, which conveys bile into the stomach, and even the whole contents of the small and large intestine.

By the powers now explained, which propel the alimentary mass by their contractions, and by the admixture of the various fluid menstrua which dilute and alter its properties, those memorable changes are effected by which our food is said to be animalized or assimilated. In the duodenum and upper part of the jejunum it forms an equably mixed fluid, of the consistence of thick cream, greyish, and rather acid. Lower down it separates into two parts; the excrementitious of a pale brown or yellow colour, and nauseating smell; and the true chyle, separated from the former by the bile, and swimming on its surface.

Action of the large Intestine. The excrementitious portion of the chyme, deprived almost entirely of every nutritive portion, enters the cæcum: its passage through the last part of the ileum being favoured by a copious secretion of mucous from the glands which abound in that part. The valvula coli, which is the boundary between the large and small intestines, is designed to prevent the contents of the former from regurgitating into the latter: and it performs this office in general; for nutritive clysters would otherwise enter the small intestines, and thus enable us to administer food enough for the support of life per anum: yet it occasionally fails in its office: hence vomiting of feces, and of tobacco clysters.

The large intestine may be regarded as the organ in which the residue of the chyme undergoes its last change; viz. the conversion into feces; as a reservoir, protecting us from the disgusting necessity of having that residue constantly flowing off; and as the instrument of its final expulsion from the body.

Some absorbents exist in this last part of the alimentary tube, and convey what nutritive parts still remain in the intestinal contents; but they are comparatively few, and hence the impossibility of nourishing the body by way of clyster.

The conversion of the alimentary residue into feces is owing to some active operation of the intestine; as these are very different from the mere putrid remains of animal or vegetable matter. And when this operation is deficient, portions of the food are seen in the evacuations per anum but slightly changed. The fecal matter is conveyed onwards by the peristaltic motion of the large intestine: it becomes thicker and more consistent in its progress, and is usually formed more or less decidedly by the cells of the colon. Its natural consistence is just sufficient to retain these marks; and its appearance throughout should be homogeneous. The colour depends on the admixture of bile, and in the most natural state is of a yellow brown. Although the change which reduces the residue of our food to feces is so far from being mere putrefaction, that the excrement is in fact less prone to putrefy than other animal matter; yet there is, as in putrefaction, a disengagement of gaseous products, particularly of sulphurated hydrogen. The colouring matter of vegetables is often seen in the feces, as the green of spinach, and red of beet root; and the fibrous indigestible parts of vegetables, as the skin of fruits, husk of grain, &c. The latter, indeed, is so little affected by the powers of digestion, that when the covering is entire, a grain may pass through the body, and still retain the power to germinate.

The expulsion of the feces takes place when they arrive in the rectum, which is

speedily irritated by their presence; and is performed partly by the muscular coat of that intestine, and partly by the muscles of respiration, producing the effort called straining. The periods of voiding the excrement vary, from several causes: they are more frequent in the young subjects, where the stools are more liquid. In the adult they should not be less, in a healthy state, than once in twenty-four hours.

Urinary Secretion. The liquids which we drink, absorbed by the lacteals, together with the nutritive part of the solid aliment, dilute the latter, and serve as a vehicle for it. They increase the quantity of the blood, and render it more fluid; conveyed into every part of the circulating system, they penetrate all our organs, carry away the particles detached from them in the different vital processes, and are then separated from the mass of fluids by the urinary organs, together with various other substances, whose retention in the body would produce injurious effects. The kidneys, therefore, dispose of the residual part of our liquid ingesta, as the feces are formed by the more solid foods, and the quantity of urine may, of course, be expected to vary according to that of the drink. All the old parts of the frame, which are constantly removed by the absorbents, while new depositions are formed by the nutrient arteries, go off in the same way; and hence the urine, although apparently a watery fluid, and called in common language water, contains a great deal of animal matter.

From the above account it will be readily understood, that the properties of the urine must vary according to the time at which it is voided after meals; the quantity of food and drink, the age and complaints of individuals, &c. Physiologists have distinguished urine of the drink, chyle, and blood. The first is a watery fluid, almost colourless, evacuated very soon after drinking, and possessing very slight urinous characters; the second, evacuated two or three hours after meals, is better elaborated, but not yet complete in its constituent principles; the last, voided after the repose of the night, has all the properties of urine in an eminent degree. In infants it possesses no phosphate of lime nor phosphoric acid, as those substances are employed in the business of ossification, which is then active. In old persons, on the contrary, where the bony system, already overcharged with phosphate of lime, refuses to admit any more, this substance is carried off by the kidneys. It is removed in the same way in rachitis and mollities ossium, where the bones become softened by its absence.

The great quantity of saline and crystallizable elements contained in the urine, account for the frequency of calculous concretions, which are found by recent and accurate analysis to vary very considerably in their composition. As there is no substance in the body which may not be evacuated by the urine, and manifest itself in that liquid, so, under different circumstances, every thing possessing a power of concretion may become the subject of urinary calculus. This diversity of constituent elements, together with the want of characteristic symptoms of the different species; and the irritation which the coats of the bladder must experience from chemical reagents, will convince us how extremely difficult, if not impossible, it must be to discover a lithontriptic that would obviate the necessity of a surgical operation.

The urine is very speedily and sensibly affected by certain substances; thus asparagus occasions a remarkable fœtor in this fluid: and turpentine imparts to it a violet odour. For a further account of its composition and physiology see the article Urine.

Almost every physiologist has noticed the rapidity with which this secretion is carried on: aqueous fluids, taken by the mouth, are sometimes separated so quickly by the kidneys, that an immediate communication has been suspected between the stomach and kidneys, on the supposition that there had not been a sufficient time for the fluid to arrive at the latter organ in the regular course of absorption and circulation. This conjecture derives no countenance from anatomy, and the size of the renal vessels explains the fact without any such supposition.

Absorption, or the process by which the chyle, separated from the food by the digestive organs, is carried into the blood, naturally follows the account of digestion. We have very little to add to what is stated on this subject in the article Anatomy.

The admission of matter into the orifices of the absorbing vessels has been accounted for in various ways. Some physiologists consider it as a case of capillary attraction. But a little reflection is sufficient to shew that the absorbents are not like capillary tubes immersed in a fluid. Besides, were

such attraction the cause of absorption, that process should be carried on with regularity. On the contrary, absorption is occasionally very deficient, when abundance of fluids is presented to the mouths of the vessels, as in oedema; and in other cases, after being for a long time inactive, it is suddenly exerted to a great extent; thus large abscesses have been dispersed in one night. Others have endeavoured to discover some propelling power which should protrude the matter subject to absorption into the mouths of the vessels. The pressure of the atmosphere on the surface of the body has been considered adequate to this effect, and the deposition of new matter by the secerning artery has been assigned as the cause of the propulsion of the old particles into the orifice of the absorbent. On this theory, secretion and absorption should correspond more exactly than they are known to do. Mr. J. Hunter acknowledged that he was unable to account for the effects produced, unless by attributing to the mouths of the absorbing vessels powers similar to those which a caterpillar exerts when feeding on a leaf.

Some suppose that the absorbents cannot take up any matter that is not fluid; consequently that animal solids must be converted into fluids before they can become fit subjects for absorption; and that probably some solvent fluid is secreted for this purpose. The latter fact rests on no direct proof, and the whole hypothesis is very unlike the simplicity observable in other parts of the animal economy. It seems better, in these difficult investigations, to note facts than to form theories; and whoever contemplates the things done in the animal body, will be astonished at the power of the vessels, by whose agency they must be effected; a whole bone may perish, as, for example, that of the thigh, and may be increased by a new one; the vascular lining of the new bone will altogether remove the dead one.

Besides the great and leading office of the absorbents in conveying the chyle into the venous system, their agency is discerned in various other parts of the animal economy. The nearly transparent fluid that lubricates the interstices of the cellular substance, and the serous exhalation poured into circumscribed cavities, are taken up by the lymphatics, which must commence in all parts of the body by open orifices. When the due balance does not exist between the absorbing and secreting vessels, the cellular substance becomes loaded with fluid (anasarca), or circumscribed cavities are rendered dropsical. Together with the lymph or fluid which the absorbing vessels derive from the sources just-mentioned, they convey from every part of the body the old constitnent materials of our organs in proportion as new particles are deposited by the arteries; and these different elements are intimately mingled and combined in their passage through the absorbent glands, and the plexures of lymphatic vessels.

It has been a disputed point whether absorption goes on from the surface of the skin, while the cuticle is entire; the arguments on the affirmative sides are an alleged increase of weight in the body after a walk in damp weather; the abundant secretion of urine after remaining for some time in a bath; the evident swelling of the inguinal glands after a long immersion of the lower extremities in warm water; the effects of mercury administered by friction, fumigation, &c. It has been stated in opposition, that oil of turpentine has not been absorbed after long immersion of the arm; that solutions of medicated substances have not been taken up under similar circumstances, &c. We think it is sufficiently proved, that absorption from the surface does take place in the human body, but whether this extends, as a modern physiologist has stated, to gaseous bodies, cannot yet be decided.

It appears probable that the internal surface of the bronchi and pulmonary vesicles is an absorbing surface. For when a person breathes air loaded with the vapour of turpentine, that substance very speedily shews itself in the urine, although the skin will not take it up. If the body really increase in weight in damp air, it might be accounted for by means of pulmonary absorption. It must probably be rather in this way, or by the skin, that contagious matters affect the constitution.

The absorbents are concerned in producing changes in the different secreted fluids: they remove the aqueous portions of the bile and urine, and often take up even the colouring parts of the former, and convey them into the blood, whence they are deposited in all our organs, and produce the yellowness of jaundice. They introduce various diseases into the human frame, as syphilis, hydrophobia, inoculated small-pox, &c.; and in other instances act in a curative manner by taking up extravasated blood, by reducing swollen parts, &c.

The circulation, is the motion by which the blood, setting out from the heart, is constantly carried to all parts of the body in the arteries, and returns to the same point in the veins. The uses of this circulatory motion are, to submit the blood altered by the mixture of lymph and chyle to the contact of the atmosphere in the lungs (respiration), to convey it to several organs in which various animal fluids are separated from it, (secretion); and to every part of the body, for supplying its growth and repairing its losses, by means of its nutritive particles when completely assimilated (nutrition). The conveyance or transport of our fluids, rather than their elaboration, is the office of the organs of circulation. In this view they may be compared to those labourers, who in a large manufactory, from which various products issue, carry the materials to the workmen employed in the actual fabrication. As among the latter there are some who purify and bring to perfection the materials furnished by others, so the lungs and secretory glands are constantly employed in separating from the blood all those heterogenous matters which could not be assimilated to the substance of our organs.

The word circulation, when used absolutely, comprehends the whole course of the blood, as well in the lungs, as in the arteries and veins of the body at large. The greater circulation is the passage of the blood from the left side of the heart, through the arteries, to the extremities of the body, and its return through the veins to the right side of the same viscus. The lesser circulation is the transmission of the blood from the right to the left side of the heart, through the lungs.

The course, which the blood takes, has been already explained in the article ANATOMY. We subjoin the proofs and experiments, by which the facts there stated are supported.

The passage of the blood through the heart, *i. e.* from the right auricle to the left ventricle, by the medium of the lungs, is manifest from the structure of the heart itself. The valves, which are placed at its various apertures, actually will not admit of the blood's motion in any other direction than what we have described. That this fluid passes from the heart into the trunk of the aorta, thence into its branches, and so on to the most minute ramifications, is evinced; 1. By the effect of ligatures on these vessels; the artery becomes turgid between the heart and the ligature, and empty between the ligature and its distribution. 2. By opening an artery when tied, above and below the ligature; the blood in this case flows from that opening only, which is nearest to the heart. 3. By ocular testimony; the passage of the blood can be seen with the aid of glasses in frogs, fishes, &c. The passage of the blood through the veins, in a contrary course to that, in which it flows along the arteries, *i. e.* from the minute ramifications towards the trunks, and thence to the heart, is proved. 1. By the structure and disposition of the valves, which afford an invincible impediment to all retrograde motion. 2. By ligatures on these vessels, which make the vein turgid between the extremities of the body and the ligature, and empty in the rest of its course. 3. By opening a vein, when tied, above and below the ligature. 4. By microscopical observation in animals.

The passage of the blood from the arteries into the veins seems to flow as a corollary, from what we have stated concerning the proofs of its course in these two systems of vessels. We have shewn that the ultimate arteries are continuous with the origins of the veins; that the blood moves from the heart to the extremities in the former vessels, and that it passes from the extremities to the heart in the latter. The intermediate passage is a direct consequence of these facts. But it may be demonstrated by direct proofs independently of this argument. If we tie the artery of a part, its correspondent vein receives no blood; if we take off the ligature the vein is again filled. The quantity of blood expelled from the aortic ventricle is so considerable, that the supply can only be kept up by its return to the heart. We calculate that two ounces are sent into the aorta at each pulsation; if we suppose 80 pulsations in a minute, 9,600 ounces will be thrown out in an hour; and 14,400 pounds in a day. The same blood, therefore, which the aorta received from the heart, must be returned to this viscus; and the only passage, by which it can return, is through the veins. Lastly, the passage of the blood from the arteries into the veins, may be proved by the direct testimony of the senses in living animals. The use of the microscope affords this proof in the transparent parts of cold blooded animals, as the mesentery and web of the foot in frogs, the tail of fishes, &c.

The motions of any part of the heart, considered singly and individually, consist in a constant series of alternate contractions and dilatations; or as they are technically named, alternate states of systole and diastole. The contractions take place as in other muscles, the dilating cause consists in the forcible entrance of blood into the cavity. The auricles and ventricles, when viewed in relation to each other, are successively contracted and dilated; the corresponding parts acting at the same time on both sides of the heart. Thus, when the auricles contract, in order to expel the blood, which they have received from the system at large, and from the lungs, the ventricles are relaxed, and therefore in a state fit for receiving this blood. When, in the following moment, the recently filled ventricles contract, in order to urge forwards the blood into the two arterial trunks, the auricles are relaxed, and become immediately distended by the current of venous blood.

The action of the heart, and of the vessels connected with it, may therefore be distributed into successive periods. In the first of these, the venæ cavæ and pulmonary veins pour their blood into the two auricles, and thus cause a diastole of these cavities. The systole of the auricles transmits the blood into the ventricles in the second period; and these latter cavities expel their contents into the arteries in the third portion of time. Thus the action of the veins takes place at the same point of time with that of the ventricles; and the contraction of the auricles is synchronous with that of the arteries.

The systole of the ventricles, which is supposed to occupy one third of the time of the whole pulsation of the heart, is accomplished by an approximation of the sides of the cavities to the middle partition, and of the apex to the basis of the heart. The whole viscus by this means becomes shorter and more obtuse. The well known fact of the heart striking against the left breast in its contraction, may seem on the first glance to refute this account of the systole of the ventricles. But, on a further examination, it can have no such effect; since the phenomenon in question depends on two causes amply sufficient to produce the effect. The swelling of the auricles, which are at the back of the heart, and particularly of the left auricle, which is interposed between the spine and the base of the left venticle, necessarily causes the point of the heart to advance towards the side; and this motion may be imitated in the dead body by injecting or inflating the muscles. The other cause consists in the connection of the large arteries, particularly of the aorta, with the base of the heart. A curved and flexible tube, when suddenly distended, becomes in some measure straightened. Thus, when the blood is impelled into the aorta, the curve of that vessel approaches more nearly to a straight line. Its posterior end being firmly attached to the vertebræ, is immoveable; to its anterior and moveable part is fixed the heart, which, by the straightening of the vessel, is obliged to describe a portion of a circle, in doing which, the apex strikes against the side. These two circumstances occur simultaneously; the venous blood rushes into the auricles at the same time that the ventricle fills the aorta. The impulse of the blood expelled by the aortic ventricle is felt in the whole arterial system; and it produces in all arteries, which come within the sphere of the touch, and which have an area of not less than one-sixth of a line in diameter, an obvious and perceptible effect, called the pulse, which is a real state of diastole of the artery, and which is ascertained to correspond exactly, and to be perfectly synchronous with the systole of the heart. The number of pulsations in a given space of time varies infinitely in healthy persons. Age is the chief cause of these varieties; but other circumstances, which constitute the peculiar state of health of each individual, have considerable effect; so that no standard can be settled which shall prove generally correct. The following numbers afford, we believe, as near an approximation as can be expected amidst so much uncertainty; they will serve at least as a comparative view in subjects of different ages. The heart of an infant, sleeping tranquilly, performs in the first days of existence about 140 pulsations in a minute; at the end of the first year the pulsations are, in the same space of time, 124,

At the end of the second year......	110
Third and following years.........	96
Seventh and following................	86
Time of puberty	80
Manhood.................................	75
Sixtieth year..........................	65

The pulsations of the heart proceed in a regular and continued succession to the last period of life, and then all its parts do not cease to act at once; but the right auricle and ventricle survive the opposite cavities for some little time, so that the former part

has been called the ultimum moriens. The blood, which returns by the venæ cavæ after the last expiration, no longer finds the usual passage through the lungs, which are contracted, but it is still urged on from behind by that which the aorta has recently propelled. Hence it is forced into the right auricle, and excites contraction in that part, by the stimulus of its presence, some time after the left side has been at rest. This congestion on the right side of the heart in the last agony explains the empty state of the arteries, particularly the larger ones, after death.

It is hardly possible to determine the velocity of the blood's motion in the healthy state; for individuals differ from each other in this respect; and considerable variety probably takes place in different parts of the body. It is generally supposed, that the blood flows in a more gentle stream through the small arteries than in the arterial trunks; and that the velocity of its current is somewhat less in the veins than in the arteries of the body. These differences have, however, been exaggerated by former physiologists. The mean velocity of the blood in the aorta is calculated at eight inches for each pulsation, which gives about fifty feet in a minute. If we reflect, that the systole of the ventricle, which gives the whole impulse to the blood, occupies only one-third of the whole pulse, the velocity of the blood's motion must be trebled in that division of the time. It is said that this velocity, which we have assigned to the blood's motion at its departure from the heart, becomes speedily diminished in its further progress; and the diminution has been deduced from various causes. The first and most powerful of these is the constantly increasing area of the branches, when compared with the trunk of an artery. (See ANATOMY.) It is a well-known law in hydraulics, that the velocity of a fluid passing through an inverted cone constantly decreases, and that the diminution of velocity is in the ratio of the increase of area. The mathematical physiologists have also noticed the effects of friction; deducing these from a comparison with the course of fluids in dead tubes. Other causes have been derived from the same source; hence the serpentine course of some arteries, the unfavourable angles by which they sometimes arise, and their communications with each other, are enumerated among the circumstances which retard the course of the arterial blood. But it must be remembered, that in viewing these retarding causes we are considering their action on the blood, as if this fluid were contained in inanimate tubes, and influenced merely by the contraction of the heart, without taking into the account any accessory impulse which may be, and probably is, derived from the arteries. This retardation has been variously estimated by different calculators, who have all made it very considerable. Hales supposes the blood to flow through the capillary arteries of a frog, at the rate of two-thirds of an inch in a minute, which will be about 650 times slower than in the human aorta. Robinson and Whytt have gone still further: the former stating, that the velocity of the blood's motion in the aorta is to that in the smallest vessels as 1100 to 1. We mention these calculations, to shew what absurdities have been committed by men of the greatest abilities, when they have applied the laws which regulate the properties of dead matter to the living functions of the animal machine. Haller's observations on the circulation in living animals (Elem. Phys. lib. vi. sect. 1, § 30) entirely overthrow these calculations. He found by his microscopical experiments, that the blood flowed generally as rapidly through the small as through the larger vessels. He states also, that in living animals it is poured out as far from a small as from a large artery. The numerous and diversified experiments of Spallanzani afford additional evidence of the same truth.

We have stated, that the blood is thrown into the arteries by separate contractions of the heart; yet these vessels are constantly full, as may be proved, by opening them during the heart's diastole. For the blood flows on in such a way, that the subsequent quantity discharged from the right ventricle, overtakes that which is before, and thus causes the pulsation of the arteries. The excess of velocity in the blood coming from the heart, over that contained in the arteries, becomes constantly less; and at a certain point ceases altogether. Here the pulse ceases also: hence in microscopical observations on the course of the blood in small vessels, its stream appears to be uniform; and it is commonly stated, that the pulsation ceases in vessels of about one sixth of a line in diameter.

The motion of the blood in the minute veins, seem to be equal to its velocity in the small arteries; this increases in the larger trunks; and there is a constant acceleration in the blood's course until it

arriving at the heart. This fluid is passing through tubes which constantly decrease in area; and it follows of necessity, that by diminishing the channel of a fluid, its course must be accelerated. Hence the trunks of the venæ cavæ return to the heart, within a given time, as much blood as the aorta carried out of this viscus.

The motion of the blood along the veins must be derived from the impulse which it receives from the heart, and from the action (if there be any) of the arteries. Its circulation in these vessels is aided by the contraction of the muscles, which must urge on the contained fluid towards the heart; since their valves prevent any retrograde motion.

We shall readily perceive, that no certain calculation can be formed of the powers of the heart, when we consider that neither the quantity of blood expelled at one pulsation; nor the distance through which it passes in a given time; nor the velocity of its course can be defined with any certainty; much less can we form any accurate estimate of the obstacles which occur to the blood's motion; which must considerably affect such a calculation. We may however approach in some degree to the truth, by collecting and comparing the results of probable conjecture. If we calculate the blood contained in the body at thirty pounds, the number of pulsations in one minute at seventy-five, and the quantity expelled from the left ventricle at each pulsation at two ounces and a half, the whole quantity will pass through the heart about twenty-two times in the course of an hour; and it will perform the circulation once in less than three minutes. The velocity with which this blood is propelled by the systole of the left ventricle may be collected from the violence with which it is ejected from a wounded artery; and the altitude to which it ascends. Blumenbach has seen it projected more than five feet from the carotid of an adult during the first contractions of the heart. Our countryman Hales calculated from his experiments, in which he measured the height of the blood's ascent in a glass tube, inserted into a large artery, that it would be thrown seven feet and a half from the human carotid: he estimates the surface of the ventricle at fifteen square inches; and thus finds that one thousand three hundred and fifty cubic inches, or about fifty-one pounds weight, press upon the left ventricle, and must be overcome by its systole. Many other calculations of the powers of the heart have been formed upon mathematical principles; but different persons have been led to such opposite results, that we are warranted from this circumstance in disregarding them altogether. Borelli makes the powers of the heart equal to an hundred and eighty thousand pounds; Keill to eight ounces. Senac observes, that if a weight of fifty pound be attached to the foot, with the knee of that side placed on the opposite one; the weight will be elevated at each pulsation: this weight is placed at a considerable distance from the centre of motion; and, allowing for this circumstance, he estimates the moving power at four hundred pound.

This power of the heart, so wonderful both in extent and duration, must be referred to the irritability of the organ, in which point of view it seems far to exceed all other muscular parts of the body. That the immediate cause of contraction in this viscus arises from the presence of blood in its cavities, is shewn by the celebrated experiment of Haller; in which the longer duration of action in the right or left cavities, was varied by influencing the supply of blood.

In the action of those muscles that depend on the will, a supply of nerves, and a distribution of blood to the moving fibres, seem to be essential conditions. It has been disputed whether or not these circumstances are necessary in the heart, and what share they may contribute to the heart's action. We may observe in the first place, that the actions of the heart are completely involuntary; that no exertion of the will can produce the smallest effect in accelerating, retarding, or otherwise affecting the actions of this part. Yet various arguments prove that the nerves exert an influence over this organ. Not to mention the peculiar arrangement of the cardiac nerves; the sympathy between the heart's action, and nearly every other function, even of the most different classes, suffices to demonstrate the connection. The vehement disturbance of the heart from the passions of the mind, must be familiar to every person from his own experience; its action is also strongly influenced by various states and affections of the alimentary canal.

The action of the heart is intimately connected with the changes which the blood undergoes in its passage through the lungs, for when respiration is obstructed, the heart's action ceases, and it may be re-

called by again introducing air into the lungs. Hence arises the importance of inflating the lungs in instances of apparent death from drowning, &c. in order to excite the heart to action. The mode in which the arteries and veins contribute to the circulation, will be understood from the account of those vessels in the article ANATOMY.

The circulation of the blood is different in the fœtus, in consequence of differences in the structure of the organs devoted to this function. See FŒTUS.

The situation of the child in utero precludes the access of atmospheric air to the lungs; these organs are consequently small and collapsed, and the lesser circulation can hardly be said to take place in the fœtal state. Although its circulation might, in this respect, be considered as more simple than that of the adult, this function becomes considerably complicated by the connection with the placentæ. A portion only of the child's blood circulates through this part, and it is no doubt so altered or modified by this passage through the vessels of the placenta, as to become more fit for the growth and nourishment of the child. No such alteration or modification has, however, been actually demonstrated in the fœtal blood. Physiologists have discovered no difference in this fluid in the various vessels of the fœtus. It is of the same dark colour in the arteries and veins. The interruption of the communication with the placenta, before respiration has commenced, is, however, suddenly fatal. Our ignorance of the functions of the placenta, and of the liver, which is of immense size in the fœtus, as well as of the changes which the fœtal blood undergoes in the complicated system of organs, which are connected with its circulation in this state of existence, leaves many parts of the subject in doubt and obscurity.

Respiration. The exposure of the blood to the atmospheric air, by which the chyle, that has entered the circulating system from the thoracic duct, is converted into blood, and by which those changes are effected in the whole mass of circulating fluid, which are essentially necessary to the continuation of life, takes place in the lungs.

The respiratory organ has been aptly compared to an empty bladder, placed in a pair of bellows, with its neck adapted to the instrument, and giving entrance to a column of air when the sides are separated. In breathing, the dilatation of the chest occasions the lungs to enlarge by the entrance of air into them from without; these viscera not possessing any means of enlargement in themselves: this is termed inspiration. The expulsion of the air, after it has served the purposes of respiration, by means of a process exactly contrary to the former, is called expiration. The diaphragm and the abdominal muscles are the chief agents in enlarging and diminishing the chest. The former muscle in its relaxed state is strongly arched, and the convexity of this arch is towards the chest. Its curved fibres become straight by the contraction: the whole muscle descends towards the abdomen, and pushes the abdominal viscera, which lie against its under or concave surface, downwards and forwards. Hence the surface of the belly rises when we draw air into the chest. In the next moment, the abdominal muscles contract and push back the viscera, and thereby diminish the chest in a degree proportionate to its former enlargement. The increase of the thorax, effected in this way, takes place in the perpendicular direction; but it may also be enlarged in its whole diameter by means of the intercostal muscles, which by elevating and twisting outwards all the ribs, push the sternum forwards, and enlarge the chest in every direction. When the action of these powers has ceased, the natural elasticity of the parts restores the parietes of the thorax to their former position. In natural respiration both these methods of altering the capacity of the chest are employed; but females seem to use the intercostal muscles more than the male subject, as the heaving of their bosom demonstrates; yet breathing can be carried on by either method, to the exclusion of the other; as we sometimes see under circumstances of accident or disease. In the case of a broken rib, where the rubbing of the broken ends would be highly painful, the chest is bound up so as to render the ribs motionless, and the diaphragm and abdominal muscles perform the whole business of respiration. When the diaphragm and abdominal muscles act together, they compress the viscera between them, and the pressure thus produced, assists in the expulsion of their contents. This effort is termed straining, and is seen in vomiting, in the act of discharging the feces and urine, and in the propulsion of the child from the uterus.

The state of the mind considerably affects the mode of respiration, although the mus-

cles of that function are so far independent of the will, that they act without any exertion of volition, and continue their functions during sleep, when all the voluntary powers are suspended. When the lover, plunged in a soft reverie, fetches a deep sigh, the physiologist observes a strong and protracted inspiration, followed by a similar expiration; crying and sobbing, differ from sighing only in the circumstance of the expiration being interrupted, or divided into several distinct periods. In gaping, which is attended with a sense of weariness, there is a large inspiration, accomplished in a gradual manner, and by a kind of effort; the entrance of a great quantity of air is facilitated by opening the mouth wide: this is followed by a complete gradual expiration. Sneezing is a strong and violent expiration, and the noise accompanying it is produced by the air passing out with rapidity, and striking against the winding parietes of the nasal fossæ. The effort, which is occasioned by the irritation of the pituitary membrane, is a convulsive motion of the muscles of respiration, and particularly of the diaphragm. In coughing the expirations are shorter and more frequent; the expelled air carries off the mucus lodged in the trachea and bronchiæ, and this discharge constitutes expectoration. Laughing is a short inspiration, followed by several short and rapid expirations.

The alternate dilatation and contraction of the chest, proceed uninterruptedly from the moment of birth to the end of life, and in a healthy adult are repeated about fourteen times in a minute, so that each act of respiration corresponds pretty nearly to five pulsations of the heart. For an account of the changes which the blood experiences in respiration, as well as those which take place in the respired air, and for the composition of the blood itself, see Respiration and Blood.

The action of the lungs upon the blood is so essential to the continuance of life, that its interruption very speedily causes death. Yet in these cases absolute death does not occur instantly, but the vital processes, although suspended for a time, may be renewed by a proper treatment; and hence arises the possibility of recovering the apparently dead from drowning, &c. On the subject of sudden deaths, we may observe, that the organic functions may subsist after the animal are extinguished, as in apoplexy, concussion, &c. The latter, however, never continue after the former have ceased, as in great hæmorrhages, wounds of the heart, asphyxia, &c. Hence the cessation of organic life is a sure indication of general death, while that of animal life is a very fallacious one.

In explaining the effect which the cessation of respiration produces, some have stated, that the lungs, being no longer distended by the air in inspiration, have their vessels folded, and consequently mechanically unfit for the circulation of blood through them. Bichat, in his excellent "Recherches sur la Vie et la Mort," has fully disproved this statement, and has shown, by incontrovertible experiments, that neither the empty state of the lungs in complete expiration, nor their distended condition in the most full inspiration, produces any obstacle to the passage of blood through the pulmonary vessels. He proves likewise, that when the cessation of the chemical phenomena of the lungs induces a cessation of the heart's action, this does not happen in consequence of the simple contact of black blood with the internal surface of the left ventricle; but in consequence of this blood, thus deprived of those principles which are necessary for maintaining the actions of parts, penetrating the tissue of the heart, and coming into contact with its fibres. The brain is affected in the same way, in consequence of the cessation of respiration; and the arrival of venous blood in this organ, causes an immediate cessation of animal life, while the organic still subsists. The same blood too, accumulated in every other structure, probably affects the whole body with its mortiferous qualities; and consequently, a mechanical inflation of the lungs with pure air, is the most powerful method of recovery that can be adopted in these cases.

The term asphyxia, signifying absence of the pulse, is applied to every apparent loss of vitality, produced by an external cause that suspends respiration, as drowning, strangling, disoxygenation of the air we breathe, &c. The difference between asphyxia and real death is, that in the former state the principle of life may be reanimated, while in the latter it is completely extinct. In those cases where it arises from drowning, strangulation, and some of the non-respirable gases as carbonic acid; the cessation of respiration is the cause, and the treatment must be conducted on the principles just mentioned. Where noxious vapours, as those of privies,

or burial places, or certain gases, as sulphurated and phosphorated hydrogen produce it; there seems to be an action of some poisonous or deleterious substances on the nervous system through the medium of the lungs. Intoxication is quite different from asphyxia; it induces a profound sleep or insensibility, in which the pulse still beats, and respiration goes on, although slowly.

The lungs are organs of secretion, and separate from the venous blood, circulating through them in the pulmonary artery, and loaded with serum, a very abundant watery vapour, called the breath, and shewing itself in separate globules when condensed by a cold and smooth surface, as that of glass or metals. As the cessation of respiration is one of the most obvious and easily recognizable symptoms of death, the intimate connection between it and life has been noticed even by the vulgar, and hence life itself, and even the soul, have been supposed to reside in the breath. Thus anima, in Latin, denotes the breath, the life, or the soul. The breath of life is a familiar phrase in our own language, and the "animam efflavit" of the poet, which literally means "blew out his breath," is employed to signify "died." We cannot admit that this watery vapour is formed by the oxygen of the atmosphere uniting with the hydrogen of the venous blood, as this combination, performed out of the body, is attended with phenomena of deflagration that do not occur in the present instance. The quantity of this secretion is said to equal that of the skin; it should be distinguished from the mucus secreted on the interior surface of the bronchiæ and trachea, which is thrown off by strong expirations, and forms the matter of expectoration.

Animal Heat. The power which living bodies possess of maintaining the same degree of heat under every change of surrounding temperature, is one of their most surprising phenomena, and one which occupies a very prominent station in that complicated assemblage of circumstances denoted by the term life. The temperature of the blood, and of the internal parts of the body in general, is stated at about 98° Fahrenheit. In Mr. Hunter's experiment, he found the heat under the tongue, and at the bulb of the urethra, to be 97°; in the rectum 98½°; in the rectum of an ox and rabbit 99½°; of a hen 103; in the heart, liver, and stomach of animals 100° and 101°. These temperatures, instead of varying like those of inanimate bodies, according to the surrounding media, and consequently tending to a state of equilibrium, are maintained with very little deviation under very great varieties of atmospheric heat. Pallas sustained a cold of 80° below 0 in Siberia, and Gmelin of 126° in the same country. On the contrary, temperatures of 120° and more, above 0 have been observed in Africa and America. Linings saw the thermometer at 126° in Carolina; but when placed under the tongue, or in the axilla, it sunk to the point of animal heat. Much higher degrees of artificial temperature have been supported by the human body. Girls in France staid in an oven where fruit and meal were baking, for ten minutes, without inconvenience, the thermometer at 265°. Dr. Fordyce and Sir Joseph Banks supported nearly an equal degree of artificial heat in this country.

From these facts it is obvious that, although in rare instances, the surrounding heat is greater than that of our own bodies, it is generally considerably less. Hence we must explain the powers by which our temperature is maintained so much above that of the medium in which we live. This explanation is now generally founded on the chemical changes which the blood undergoes in the lungs, and in its circulation through the body, which subject is considered under the article HEAT. There are many circumstances in favour of this explanation; as the increased heat produced by the acceleration of the circulation from exercise, &c. the coldness of a limb, when the nutrient artery is tied; the various degrees of temperature in different animals corresponding with the perfection of their pulmonary system, &c. There are also several facts which show that the living powers of the constitution, or part, greatly influence the evolution of heat, independently of the consumption of oxygen in respiration. The coldness of palsied limbs, the increased heat of parts in inflammation, and of the whole skin in febrile complaints, are sufficient to prove this. But it is most clearly demonstrated by an experiment of Dr. Currie's. He placed a man in a cold bath of 40°, which at first diminished his temperature, but it soon regained the natural standard. Here there must have been a great evolution of heat to keep up the temperature under circumstances so strongly tending to depress it; yet the consumption of oxygen was less than usual, for both the pulse and respiration became slower. Mr. Hunter

made many experiments on this subject, and concluded that there is always an exertion or expense of animal power in resisting cold, proportioned to the necessity of the case; that this exertion is in proportion to the perfection of the animal, and to the degree of heat natural to the species, and that it is independent of circulation, volition, and sensation.

The power of resisting heat arises from the evaporation that is constantly going on from the surface of the skin, and which becomes extremely abundant when the temperature of the air is much raised. See the account of the organ of touching. This is a very powerful means of diminishing animal temperature, and consequently, when long continued, has a very weakening effect. Of fourteen persons shipwrecked in December, three sat on the deck, out of water, but exposed to sleet, snow, and wind; the evaporation from their surface must have been immense, and they died. All the others were up to the middle or shoulders in the water for twenty-three hours, yet survived.

Animal heat may be altered from its standard by external applications or disease; but the change can be carried much further below the standard than above it. A man could bear to have his penis cooled to 50°; but it could not be heated beyond 100½°; although the heat employed raised a dead penis to 114°.

Secretion. The blood, circulated in the manner we have just mentioned, and prepared by the organs of respiration, is the source from which the various fluids of the animal body are formed in the process of secretion.

The various arrangements of these products are, in a great measure, arbitrary. Milk seems to be formed by the most easy process, as it resembles so strongly the nature of chyle. Next come the watery fluids; (so called from their appearance, although in composition they differ considerably from water, chiefly in containing albumen). The humours of the eye, the tears, sweat, lymph of the cellular substance, vapour of the thorax, abdomen, and pericardium, and the water of the ventricles belong to this class. The urine seems to come under the same head, although it is of a peculiar and compound nature; next follow the salivary and pancreatic juices; and then the mucous fluids poured into the alimentary, respiratory, and generative organs. The fat, marrow, grease of the skin, ear-wax, sebaceous matter of the eye-lids, and of the external organs of generation in both sexes, constitute the class of adipous fluids. The liquor of the amnion, the synovia of the joints, and the prostatic fluid, are of a gelatinous kind. The male semen, and the bile, are both of a very peculiar nature. The chemical analysis of these fluids will be considered under their proper articles.

These very various products are separated from the blood by very different organs. The most simple mode of secretion is that performed by the arteries of a part without any glandular apparatus; as the fluids of circumscribed cavities, the lymph of the cellular substance, and the fat and marrow.

Secretion is more complicated when performed by means of certain organs called glands. The most simple of these are the mucous follicles, found in various parts of the alimentary and respiratory canals; consisting of a small bag receiving the secreted fluid from the arteries, and expelling it through a short excretory duct. But the name of gland is applied more properly to the larger organs of complicated structure, as the pancreas, breast, salivary glands, &c. These, consisting of an aggregation of minute particles, are called conglomerate, to distinguish them from the lymphatic or conglobate glands. Each of them possesses an excretory duct, made up by the union of branches from the various component portions of the gland. The larger portions, into which each gland is resolved, may be divided into smaller and smaller particles, and ultimately into very minute portions; concerning the structure of which, anatomists have warmly disputed. Some described them as being hollow, and called them acini, or cryptæ; while others asserted that they consist merely of convoluted blood-vessels: the latter opinion is the most prevalent at present. The structure of the liver and kidney is analogous to this, in its minute parts: both these organs, and particularly the latter, exhibit the acinous appearance. The ultimate blood-vessels are arranged in very different ways in various glands; coiled up in roundish masses, as in the kidney, arranged like stars in the liver, and forming an appearance like a camel's hair pencil in the spleen.

The various properties of secreted fluids depend, no doubt, more on the interior texture and vital powers of the secreting organs, than on their external habit and conformation. For comparative anatomy shows us

instances of the same fluid secreted by organs of very different obvious structure.

How, or why, certain organs secrete certain liquors, is the most important and essential question in this subject; but one to which our ignorance will not enable us to reply in a satisfactory way. Probably the chief and proximate cause consists in difference of structure, and perhaps in the arrangement of the minute vessels, which are the organs of secretion. The peculiar powers of each part, its share of irritability, and contractility, must also have an important influence. The mechanical explanation of the phenomenon, by the straining of the fluids through different sized pores, cannot be admitted for a moment. We have one fluid, the blood, sent into different organs; each of which separates from it a different produce of matter, differing in many instances from any contained before in the blood. Here then must be a decomposition and a recombination of elements produced by the living action of the gland.

Nutrition may be considered as the completion of the assimilating functions; to which the processes hitherto described, under the heads of Digestion, Absorption, Circulation, Respiration, and Secretion, are only preliminary and preparatory. The food, changed in the manner we have already described, animalised and rendered similar to the being which it is designed to nourish, applies itself to those organs whose losses it is to supply, and this identification of nutritive matter to our organs constitutes nutrition. The component parts of the living body are incessantly carried off by various causes. Thus the machine is continually destroyed, and at distant periods of life does not contain any of its original elements. Madder, mixed with the food, dyes the bones of a red colour, which disappears when the use of the root is suspended. These phenomena can only be explained by admitting an entire removal and renewal of the bony particles. Now if the most compact and solid parts be in a continual motion of decomposition and recomposition, this motion must be more rapid where the constituent principles are in the smallest degree of cohesion, as in fluids. Physiologists have endeavoured to determine the period of the entire renovation of the body, and have considered that an interval of seven years is necessary for the original particles to be totally obliterated, and their place supplied by others.

When the nutritive matter has been duly assimilated, the parts which it supplies retain it, and incorporate it with their own substance. This nutritive appropriation is variously effected in different structures; since each part converts to its own use, by a true secretion, that which is found analogous to its nature, and rejects the heterogeneous particles.

The mechanism of nutrition would be explained if we could understand how each function divests the aliments on which we exist, of their characters, to invest them with the properties of our organs; how each individual part co-operates in changing their nutritious principle into our own peculiar structure. Vegetables, which form the sole nourishment of man in many instances, and a very great share of it in all cases, consist chiefly of carbon, hydrogen, and oxygen, with sometimes a small quantity of azote and salts. In the organs of the man fed on these vegetables, azote predominates, and many new products are discovered, not distinguishable in the aliment, and *therefore* formed in the act of nutrition. Every *living* body, without exception, possesses this faculty of forming and decomposing substances, and of giving rise to new products.

The marine plant, whose ashes form soda, if sown in a box filled with earth that does not contain a particle of that alkali, and moistened with distilled water, furnishes it in as great a quantity as if the plant had been growing on the borders of the sea, and always supplied with salt water. Living bodies then are elaboratories, in which such combinations and decompositions occur, as art cannot imitate; bodies that to us appear simple, as soda and silex, seem to form themselves of other parts; while some, whose composition we cannot determine, as certain metals, suffer inevitable decompositions; from which we may fairly conclude, that the powers of nature in the composition and decomposition of bodies far surpass the science of chemists.

SENSATIONS.

Vision. The mode in which the rays of light are affected, in passing through the various parts of the eye, is explained under the article Optics. See also Vision. We have only to add a few remarks on the physiology of the eye.

The quantity of light that can enter the eye depends on the state of the pupil; which is again influenced by the motions of the iris. When, after shutting the eye-lids, they are suddenly opened in a strong light, a disagreeable impression takes place on

the eye, and the iris dilates or becomes broader: hence the pupil is contracted, and the quantity of light admitted into the eye diminished. An opposite change takes place when we go from a strong into a weak light. These motions depend entirely on the mode in which light affects the retina; for the iris is of itself insensible to luminous rays. The painful effect produced on the retina by a strong light is obviated by the contracted state of the pupil; while the opposite condition of that opening, in darkness, is designed to admit a sufficient quantity of rays, to produce a proper impression on the retina.

The seeing of bodies erect, although their images are painted inverted on the retina, is thus explained. An object is said to be inverted in respect to others, which are erect: now all objects whatever are painted inverted on the retina, and all therefore correspond to each other in situation and connexion, just as if they had been represented in their natural position. All confusion is, therefore, guarded against in the mind; to which the image itself on the retina is not communicated, but only an impression caused by its formation.

The motion of the iris contributes to distinctness of vision by regulating the quantity of light admitted into the eye: and there is another provision tending to the same effect; viz. the absorption of any superfluous rays, which may have entered the eye by the black covering of the choroid coat. The utility of this dark pigment may be understood from observing the effects of its absence in the albino, where it causes a tenderness of the organ, and an impatience of the light.

Distinct vision also requires that the focus of the refracted rays should fall exactly on the retina, without falling short of it in the vitreous humor, or being elongated beyond it. The former fault constitutes near-sightedness (myopia); where the cornea and lens are too convex, and the sight of remote objects is imperfect. The latter defect is far-sightedness (presbyopia, as being common in old persons); where an opposite condition of the eye obtains, and near objects are seen imperfectly.

As the eye possesses a very considerable range of power in seeing distinctly both near and distant objects, it must possess some powers of accommodation adapting it to these differences of distance. Various opinions have been held on this subject; but none are supported by sufficiently direct and convincing arguments to command universal assent. The changes in the condition of the pupil have some effect: it contracts when we look at a near object, to exclude those rays which would be too divergent for the powers of the eye; and it dilates in the opposite case, to take in the divergent rays. Besides this, different physiologists have admitted a power of motion in the crystalline, by which its convexity may be altered; a movement of that body backwards and forwards, in the eye, by the ciliary processes, so as to place it at different distances from the retina; a compression of the globe by the four recti muscles, and consequent elongation and shortening of the optical axis.

That the retina, in the very axis of the eye is insensible, owing to the entrance of an artery at that part, is shewn by experiments, in which objects vanish when their images are brought on that point.

Single vision, with two eyes, probably arises from habit; for children seem to see double; and the same affection, after diseases, has been conquered by use.

The sight would lead us into many errors concerning the distance and figure of objects, were it not corrected and assisted by the touch. The person born blind, mentioned by Cheselden, thought when he had gained his sight, that all objects touched his eyes. A square tower, at a great distance, appears round; and lofty trees, in a distant perspective, seem no larger than small bushes that are nearer to us.

Hearing. The undulations of the atmosphere, excited by the vibrations of sonorous bodies, are collected in the external ear and auditory passage, as in a hearing trumpet, and are conveyed to the membrana tympani, which they cause to vibrate. The effect is transmitted through the small bones to the watery fluid that fills the internal ear, in which the delicate filaments of the auditory nerve float; and by this nerve the sensation is conveyed to the brain. Muscles attached to the small bones of the tympanum have the power of stretching or relaxing the membrane; and probably thereby adapt the organ to various quantities of sound, by diminishing acute, and augmenting the force of grave sounds, as the changes in the pupil of the eye accommodate that organ to a greater or less number of rays according to the effect they produce.

An entire state of the membrana tympani is not essential to hearing; for the sense re-

mains, where an opening has taken place in that part; yet it is necessary that the tympanum should communicate with the fauces, for an obstruction of the eustachian tube causes deafness.

Vibrations may be transmitted to the auditory nerves through the bones of the head; thus, a watch placed between the teeth is heard very distinctly, although the ears are stopped, &c.

Smelling. The odorous effluvia of bodies are disseminated in the atmosphere. The latter fluid passes through the nose in respiration, and thereby brings the odorous particles into contact with the olfactory nerves, which convey the impressions of odours to the brain. It is in the first pair of nerves only that the sense of smelling is supposed to reside, while the numerous twigs of the fifth pair that are distributed in the nose are merely for the purpose of general sensibility. Hence we see two very distinct modes of sensibility in this part, one of which may be entirely obliterated, while the other is augmented; in violent coryza the ordinary feeling is very acute, for the pituitary membrane is painful; but the person at the same time is not conscious of the strongest odours.

As air is the vehicle of odours, its passage through the nose, in ordinary respiration, is sufficient for the purpose of smelling; but when any odour is particularly agreeable, we make short and repeated inspirations, and at the same time shut the mouth, that the air, which enters the lungs, may pass entirely through the nose. On the contrary, we breathe by the mouth, or entirely suppress respiration when odours are unpleasant to us.

The small distance between the origin of the olfactory nerves in the brain, and their termination in the nose, renders the transmission of impressions very sudden and easy. This induces us to apply to the nose stimuli that are proper to revive sensibility when life is suspended, as in cases of fainting, suffocation, &c.

Tasting. No body can affect the organ of taste, that is not soluble at the ordinary temperature of the saliva. Hence the chemical maxim, "corpora non agunt nisi soluta," may be very justly applied to this sense. If the tongue be completely dry, and a body applied to it be also dry, no sense of taste ensues, as any one may convince himself by wiping his tongue dry and applying sugar to it. The state of the tongue's surface, which is well known to depend much on the condition of the stomach, also impairs our sense of taste; hence in some disorders every thing tastes bitter.

No sense approaches more nearly to feeling, than this does; and the organ bears a considerable analogy to that of the sense of touch. The superior papillous surface of the tongue is the organ of taste, but we cannot deny the power of discerning savours to other parts of the mouth; bitter substances are particularly tasted about the throat; and in some instances where large portions, or the whole tongue have been cut away or destroyed, a perception of tastes has still remained. The lingual branch of the fifth pair is considered as the true gustatory nerve, while those sent to the tongue by the eighth and ninth are regarded as merely nerves of motion. Although the tongue appears to be a single organ, it consists of two symmetrical halves; and should be considered as a distinct right and left organ closely applied to each other. This is shewn in hemiplegia, where one-half only is paralysed.

Touching. The whole surface of the skin is the organ of this sense, which gives us information concerning more properties of extraneous bodies than any other of our senses. The sight, hearing, smell, and taste, are confined to circumscribed limits; while the touch, distributed on the whole surface, effectually provides for our preservation, by giving us notice of the approach of external bodies, and informing us of their properties. Every thing that is not sound, light, odour, or savour, is appreciated by this sense, as the temperature, consistence, dryness, or moisture, magnitude, distance, &c. of objects. It corrects the errors of sight and the other senses, of which it may indeed be justly termed the regulator; and, above all others, furnishes us with the most certain and exact ideas. Exercise and cultivation bring it to a wonderful degree of perfection, so that in blind persons it may almost be said to supply the loss of sight; in some such instances different colours and their various shades have been distinguished by its assistance.

Although the tangible qualities of bodies can be perceived by every part of the cutaneous organ, it possesses in some situations a more delicate structure, consisting of fine pointed prominences, called papillæ, endued with greater sensibility and vascularity, and thereby constituting in a more especial manner organs of touch. This is the case with the hands. The number of

bones that compose these organs render them susceptible of infinitely varied motions, and enable them to explore with accuracy the surfaces of the most unequal bodies. The soft ends of the fingers receive large nerves and arteries, and possess very numerous and prominent papillæ. This finely organised skin is formed into a gently convex protuberance by an accumulation of a soft fat under it, and it is defended and supported by the nail; and accordingly these pulpy extremities of the fingers are endowed with the most refined sense of touch. The lips and the glans penis have a similar structure, and receive from this organization a very exquisite sensibility, which is a modification of touch.

As the cutaneous papillæ are covered by the epidermis, it follows that the very superficies of the body is insensible. The cuticle and its appendages, the nails and hair, have neither vessels nor nerves, and possess no powers of life or growth in themselves. It forms a medium, moderating the impressions which would be too vivid from an absolute contact of substances; when preternaturally thickened, as in the hand of the labourer, it obstructs sensation; and when entirely removed, as by a blister, the contact of bodies excites pain. It is also important in preventing the action which the atmosphere would otherwise exert in drying the surface of the body; when removed in the dead subject the skin immediately becomes horny, and the same effect extends more or less to the subjacent parts; in the living body its removal is followed by incrustation or scabbing.

The skin is also to be considered as an organ of secretion, and perhaps of absorption. Under the former head we view it as the means of separating and expelling from the body extraneous matters, whose retention would be injurious to the system. This may be proved by eruptive disorders, by the odours of musk, garlic, &c. which affect the perspiration; by the phenomena of sweating, &c. by the injurious effects on the system at large, which a suppression of the cutaneous secretion causes, and the relief experienced by sudorific remedies in various cases.

The secretion from the skin has been divided into the sensible and insensible. An abundant vapour continually exhales from the whole surface, and has the name of insensible transpiration, or perspiration, when it is invisible to the naked eye, and passes off in the state of gas; but it is called sweat, when, becoming more copious, it flows in form of a liquid. The innumerable arteries, which pervade every part of the skin, are the source of these secretions; and their exhaling orifices are supposed to penetrate the cuticle in a state far too minute for any means of research that we possess. If the naked body be placed against a white wall in the sun during the summer season, a shadow produced by the cutaneous exhalation may be perceived; and the following is also a decisive experiment to the same point. Apply the end of the finger near a glass or finely polished metallic instrument, and the body will soon have its surface tarnished by a vapour which is dissipated when the finger is removed.

A great resemblance exists between the cutaneous and pulmonary secretions; both are simple arterial exhalations, and the mucous membrane of the aerial passages is a continuation of the skin. The two secretions counterbalance each other; and the connection between them is evidenced by the remarkable distress of breathing attendant on extensive burns. There is a similar connection with the mucous exhalation of the intestinal canal; and a still more remarkable one with the kidneys.

The quantity of the insensible perspiration appears by experiments to be very great. Sanctorius, a Venetian physician, who first noticed its importance and extent (whence it has acquired the name of perspirabile sanctorianum) estimated it at five pounds in twenty-four hours, when the solid and liquid food amounts to eight pounds. In temperate climates it may be from two to four pounds daily; but it varies according to numerous circumstances.

The chief bulk of insensible transpiration and of sweat is water; it holds several salts in solution. Carbonic acid gas is also found in considerable quantity; and even according to some experiments, azote and hydrogen. An oily or sebaceous matter is secreted from the skin, to preserve the cuticle in a proper condition of suppleness; hence water is repelled from the naked body, when thrown on it. There are also some volatile and odorous particles furnished from the same source, in which the peculiar smell of individuals and of nations resides.

Sweat seems to be nothing more than an increase of the insensible perspiration produced by augmented action of the cutaneous vessels. Increased temperature and exercise give rise to it; and it furnishes the

most powerful means of reducing that augmented temperature, according to the well known frigorific effects of evaporation. Hence the human body has borne a greater heat than that of boiling water, without having its own temperature raised.

Functions of the Brain and Nerves.—The organs of the animal functions, which keep up the connection between the body and the faculties of the mind, and are therefore found only in animated organized bodies, may be conveniently divided into two classes; the sensorium, and the nerves: the latter including the nerves and their origins from the brain; the former comprehending the rest of the cerebral organ, by which the offices of the nerves are connected with the more noble part of our frame, the faculties of the mind; and which may therefore not unaptly be termed the organ of the mind. For the differences which animals present in a comparison of the proportions of these parts, as well as in the size of the brain altogether, &c. see COMPARATIVE ANATOMY.

The brain, when brought into view by a removal of the cranium, presents a double motion; it rises slightly during expiration, and subsides again when the thorax is dilated. This is explained from the temporary obstruction which the return of the venous blood experiences when the lungs are compressed. But a more conspicuous elevation and depression of the cerebral surface arises from the impulse of blood into the arteries of the head; this motion is therefore perfectly synchronous with the pulse, and may be felt in every infant whose fontanelle is not closed. The quantity of blood received by the brain is very considerable; according to Haller's calculation, between two-thirds and a half of the whole mass of blood that enters the aorta. This blood is circulated through all the minute and numerous arterial ramifications of the pia mater, before it enters the brain, as it should seem, in order to diminish its impulsive force; it rises contrary to its gravity, and its conducting tubes have an angular and tortuous course before they branch out on the pia mater; which circumstances augment the retarding effect. Every thing, on the contrary, facilitates the blood's return, and prevents venous distension.

The vast and wonderfully complicated vascular apparatus of the brain, and the large proportion of blood sent to the organ, naturally lead us to expect, that this part and the heart are closely dependent on each other. If the cerebral arteries be all tied, the animal perishes instantly. The influence of the heart, essential to the preservation of life, does not seem to consist so much in the agitation which the cerebral arteries communicate to its substance, as in the effect which the arterial or oxygenized blood exerts on it. For if venous blood be sent into the head instantaneous death ensues; and this seems to be the way in which the cessation of respiration, by drowning, hanging, &c. proves fatal.

Nerves, which arise from the brain and spinal marrow, and are the organs conveying the impressions of external objects to those parts, are not found in all structures of the body. The cellular substance; cuticle, rete mucosum, hair and nails; cartilages, bones, teeth, periosteum, and marrow; tendons, aponeuroses, and ligaments; membranes, as the dura mater, pleura, pericardium, peritoneum, &c., the cornea, &c., the absorbent system, the secundines and umbilical chord, are in this predicament. For an account of the disputes which have arisen concerning the sensibility of these parts, see the introductory remarks on sensibility and contractility.

The ultimate points of origin of the nerves from the brain, are hitherto hardly determined; so that it is still questioned, whether or no the right and left nerves decussate. That this is the case in the optics is tolerably clear; and the fact, that injury of one side of the brain causes paralysis of the opposite side of the body, has led to an inference, that the same decussation obtains in all the nerves. The ganglia and plexuses, in which different nerves are united together, probably perform an office analogous to the arterial communications; that of preserving the connection of any part with the brain, when the direct communication is cut off.

Physiologists have endeavoured to trace the termination of nerves in the organs which they supply; but the research is almost too subtle for our imperfect modes of investigation. In some instances, as the optic and auditory, they are manifestly resolved into a soft pulp: and we conjecture, by analogy, that the same mode may obtain in others. There are some obvious differences, which may account for the different mode of affection in the various senses. The retina, which is the expanded end of the optic nerve, is of so delicate pulpy a nature, as to approach to fluidity, and it is

acted on only by the rays of light, which are not perceived by any other sense: the auditory nerve, which alone perceives sounds, is rather firmer, &c.

That the mind is very immediately and essentially connected with the brain, and that the animal functions of sensation and voluntary motion, are no less intimately dependent on the same organ, may be proved by such an abundance of physiological and pathological phenomena, that no doubt can be entertained of the fact. An injury of this organ suspends or annihilates the whole, or a part, of the mental operations, and puts an end to all feeling and motion: the organs of the body remain entire, the nerves connecting these with the sensorium are uninjured; but the perceptive faculty is lost. Again, an injury of one side of the brain often causes a loss of feeling and motion in one side only of the body; which, in consequence of principles inexplicable by us, always affect the opposite half to the injury. That the sensible impressions made on our organs are conveyed by the nerves to the brain; and that the latter part is the seat of the sensation, although it is referred by the mind to the part itself; is proved by cutting or tying a nerve: in which case, the usual impression causes no perception. The truth of this assertion, which will hardly meet with credit among the uninformed, is illustrated by what happens to persons whose limbs have been amputated: they are constantly complaining of pains in the toes or fingers of the limbs they have lost. Here the middle of the nerve is irritated, but the pain is referred by the mind to its extremities.

Yet, although the influence of the brain be thus essential, in the business of sensation and voluntary motion: and an unimpaired state of the nerves passing between the organ and the sensorium, be consequently an indispensible condition in those functions, other departments of the animal economy are not so immediately subject to the power of the brain. The processes of digestion, absorption, circulation, secretion, and nutrition, those, in short, which constitute the internal life, still go on when injuries of the brain have suspended the animal functions: nay, they may survive for months or even years. The ligature of the nerves of a part does not destroy its circulation or nutrition; although these processes may perhaps be impaired. How, then, will it be said, Does an injury of the brain so often prove fatal? The individual ought still to live internally, although his external life has been annihilated. But here we notice a function that partakes of both: namely respiration. The dilatation of the chest can only be performed by means of muscles, whose principle of action comes from the brain: as the injury of the latter organ has paralysed these, the blood can no longer receive those changes which it undergoes in respiration, and thereby becomes unfit to stimulate the heart to action, or to keep up the powers of life in any of the organs of the body.

That the nerves are, as we have described, the medium of connection between the mind and its organs, is clear; but how their offices are performed is a much more obscure question. It has occupied the attention, and engaged the experiments of physiologists, in all ages; but nature has not hitherto lifted the veil, and the subject remains nearly in its original obscurity. An oscillatory or vibratory motion of the nerves; or a nervous fluid contained in or adhering to these organs, have been assumed in explanation of the facts. According to some, the latter is a liquid contained in tubes; while others liken it to caloric, light, oxygen, the electric or magnetic fluids. The partisans of the latter opinions consider, that the recent discoveries of galvanism add much weight to their arguments. See GALVANISM.

A supposed central point, to which all sensations are carried, and from which all motions emanate, is called the sensorium commune; and is considered as the seat of the soul. Des Cartes placed this in the pineal gland, others in the corpus callosum, pons Varolii, corpora striata, &c. The learned Soëmmerring has lately endeavoured to show, that the seat of the soul must be in the water of the ventricles, as he has succeeded in tracing the origins of all the nerves from the sides of these cavities. The records of morbid anatomy refute many of these opinions, as they show the parts considered as sensoria to have been diseased and destroyed without any impairment of the mental faculties.

The curious and complicated structure of the brain has led some to suppose, that particular powers resided in certain eminences or depressions of the brain; and this is the foundation of the peculiar notions of Dr. Gall, whose speculations have attracted so much notice. He contends, that the inequalities of the brain's surface are the seat of the mental powers, and of the various

propensities, &c. of the human species; and that these are accompanied by corresponding irregularities of the skull, discernible by external inspection. The whole fabric of his speculations is, however, too visionary for serious refutation. See Rees's "Cyclopædia, article CRANIOLOGY.

The consideration of the various mental powers belongs to the science of metaphysics, and will be pursued under the proper articles.

Sleeping and Watching.—Sleep is the repose of the organs of sense, and of the voluntary motions, by means of which the communication of the senses with external objects is interrupted. It is the result of that law which subjects the actions of the exterior or animal life to periods of intermittence. The most perfect sleep is that in which all the functions of this class are suspended, as the sensations, perception, imagination, memory, judgment, locomotion, and the voice; the least perfect affects only a single organ. Between these extremes, every gradation may occur; and, from the partial suspension of some functions, while others are going on, arise dreams, and the various phenomena of somnambulism. It is, however, the same principle whether observed in the relaxation that follows the contraction of a voluntary muscle, or in the entire suspension of the animal life.

Watching may be considered as a state of considerable effort and expenditure of the sensitive and moving principle by the organs of our sensations and motions. This principle would soon have been exhausted, if its reparation were not facilitated by long intervals of rest. Sleep and watching therefore call for each other, and are of reciprocal necessity.

Sleep, however, only suspends that portion of life, the design of which is to maintain a commerce with external objects necessary to our existence. The interior, or assimilating functions, are still carried on. Digestion, absorption, circulation, respiration, secretion, and nutrition are continued: the two former, indeed, seem to be performed with greater energy, while the rest are rather diminished. The pulse is slower, respiration less frequent, perspiration and urinary secretion less abundant.

Numerous causes of excitation constantly acting on our senses during the day, keep them in a state of activity; and the absence of these at night is favourable to the repose of our organs. By multiplying and increasing stimuli, the period of repose may be put off; but these gradually lose their powers, and after a certain time nothing can hinder its approach. Exhausted by fatigue and watching, the soldier sleeps at the side of the cannon; the slave reposes under the blows of his master; and the criminal sinks to rest amidst the agonies of torture.

Sympathy. All parts of the living body are united by certain relative connections, named sympathies, which establish a concord and harmony between the actions of the animal machine. The nature of this phenomenon is still obscure: we know not why, when one part is irritated, another very distant organ should perceive this irritation, and even contract; nor are we agreed on the peculiar instruments of sympathy, that is, on the organs which connect two parts, one of which perceives or acts while the other is affected. That the nerves cannot be considered as the exclusive means of it is obvious; since muscles supplied from the same source do not always sympathise, while a close intercourse sometimes subsists between parts whose nerves have no immediate connection. Often also the sympathy is not reciprocal. Examples of this principle may be seen in the swelling of the breasts from distension of the uterus; itching of the nose from worms in the intestines, and of the glans penis from stone in the bladder; contraction of the diaphragm from irritation of the pituitary membrane; pain in the shoulder from inflamed liver, &c.

The chief, and perhaps most extensive source of sympathy must be referred to the nerves, and particularly to a reaction of the sensorium. When a part is stimulated, and the sensorium affected by its stimulation, the latter reacts through the nerves on another organ, and incites it to action, although there may be no immediate nervous connection between them. The motion of the iris, arising from the impulse of light on the retina; that of the diaphragm in sneezing, from irritation of the pituitary membrane, are examples. Other modes of sympathetic connection, without the immediate concurrence of nerves, are pointed out by physiologists; as by blood vessels, in the sympathies of the uterus and breasts from the anastomoses of the epigastric and internal mammary arteries; by lymphatics; by analogy of the respective functions, as the sympathy of the lungs and common integuments.

Habit, or the reiterated repetition of

certain acts or motions has a powerful influence in the animal economy. But it operates much more decidedly on the animal, or exterior, than on the organic, or interior life. It has the effect of diminishing the sensibility of our organs, as appears from the effect of using pessaries in the vagina, catheters in the urethra, &c. Relative pleasure or pain are brought by the influence of this principle to the state of indifference. Things are agreeable or disagreeable by a comparison between the impression they make on the senses and the state of mind receiving that impression. Hence the impressions produced on our organs in the cases just mentioned, although at first painful, are soon disregarded. Pleasant sensations are the same. The cook and the perfumer are not alive to the enjoyments which they procure for others. The pleasing emotions connected with the sight and hearing are soon rendered obtuse by repetition; and any pleasure constantly repeated produces the same series of feelings; *viz.* pleasure, indifference, satiety, and even aversion. The mind is the centre of these changes. It institutes a comparison between the actual sensation and the preceding impressions, and in proportion to the difference between these will be the vivacity of the present impression. It belongs, therefore, to the nature of pleasure and pain to destroy themselves, and to cease to exist because they have existed. The art of prolonging the duration of our enjoyments consists in varying their sources.

Habit, however, which deadens sensation, augments and brings to perfection the judgment.

Most of the functions of the organic life are removed from the dominion of habit; *viz.* circulation, respiration, &c.; yet the influence of this principle is unquestionable in some parts of the organic functions, as the urinary secretion, evacuation of feces, hunger and thirst, &c.

Voluntary Motions and Muscular Action. Having already gone over the subject of sensation, one of the offices of the nerves, the other, motion, remains for consideration. The motions of the body have been commonly divided into two classes, the voluntary and involuntary. The action of the heart, stomach, and intestines, &c. exemplifies the latter; while the former are the actions of almost all the other muscles of the body. Some are of a doubtful nature, as those of respiration, of the ossicula auditus, and the cremasters. Different physiologists assign these to one of the above classes, or to a mixed division.

The arrangement is not unexceptionable. There are few functions entirely free from the operation of the will, if we consider the connection of the imagination and passions of the mind with that power; as, on the contrary, many muscular motions, which were originally arbitrary, become by the force of habit quite involuntary. Thus we can hardly bend the little finger without the ring finger; and cannot help winking if a person brings his finger rapidly towards our eye, although we are certain that he will not strike us. Again, muscles which usually obey the will, refuse obedience under certain circumstances; hence the difficulty of describing a circle with the hand and foot of the same side in opposite directions, of moving the two hands with an opposite circular motion, &c. Numerous instances might be quoted of the power of the will over motions that are usually involuntary; we shall merely mention the fact, supported by the personal testimonies of Drs. Barnard and Cheyne, of an English officer who could influence the action of his heart and arteries ("Treat. on Nervous Diseases," p. 307.) Perhaps these phenomena may be accounted for by a reaction of the sensorium, excited by a mental stimulus.

We may observe of the voluntary motions in general, that they form the chief character that distinguishes the animal and vegetable kingdoms. No plant has yet been discovered that seeks its food by voluntary motion; nor, on the contrary, is any animal known, that does not either possess a power of locomotion, or at least procure its food by the voluntary motion of some organ or member.

These motions in our own bodies shew the very complete harmony between the mind and the material fabric, as we shall readily admit, when we observe the wonderful celerity with which the fingers of the violin player, or the organs of speech of a person speaking, move, and recollect that an act of volition is necessary for each motion.

The distinguishing characteristic of muscular fibres is their irritability, the quality by which they contract in obedience to the will, or on the application of stimuli. This is an endowment residing in all muscular organs, but not in equal degree. The hollow muscles, which are subservient to the vital functions, hold the first rank; these

are followed by the muscles of respiration, and the other voluntary muscles close the enumeration. It is doubted whether the arteries or the large venous trunks be irritable.

The contraction of a muscle consists in a shortening of its fibres, which are marked by transverse rugæ, and feel indurated. But although its length is thus diminished, its circumference is proportionally enlarged. These circumstances produce an approximation of the moveable points to which the muscle is attached, and in this way all the motions of the body are performed.

An uninterrupted supply of blood, and connection with the brain by the nerves, is essential to the voluntary action of muscles: ligature of the arteries or nerves destroys this power. But these organs still retain the faculty of contracting on the application of stimuli, even after the connection with the brain be cut off, and the animal be in other respects dead: this power is the irritabilitas of Haller, the vis insita, or muscularis; which, as that great physiologist and his followers contend, is peculiar to the muscular fibres exclusively. That this property does not depend on the nerves, is clear from the fact of several parts supplied with nerves not possessing it; and from its remaining after the nerves of a part have been divided.

The nerves may perhaps be regarded as the more remote or exciting causes of muscular motion, of which irritability is the proximate or efficient cause. The passions of the mind act on the sensorium, which re-acts on the nerves of the heart, and thus heightens the irritability of that organ, exciting palpitation and other irregular motions. The operations of the will on our organs of motion may be explained in the same way.

This distinction of the causes of muscular motion may be supported by the experiments in which the irritability of the muscles has remained after paralysing a part, by tying or cutting its nerves; and by cases of paralysis, in which sensation has remained in a limb after its power of motion had ceased, or *vice versa*.

As it would be a fruitless labour to enumerate and consider all the hypotheses that have been framed concerning muscular motion, we shall pass over that part of the subject, and refer the reader to the article GALVANISM for an account of the effects of that principle on the muscles.

The real power of muscles is immense. In the human body they are generally inserted near the centre of motion, and consequently with a mechanical disadvantage; so that much of their force is expended in overcoming this obstacle. Hence it has been calculated, that the deltoid exerts a force equal to 2568 pounds, to surmount a resistance of 50 pounds. The force with which a muscle contracts is in a direct ratio with the number of its fibres; but the degree of its contraction, and consequently the extent of motions that it can effect on the limb, is relative to the length of the fibres. The precise limits of contraction in each fibre cannot be assigned; for though the long muscles of the extremities are supposed to diminish only a third of their length in contraction; the circular fibres of the stomach, which, in the state of extreme dilatation of this organ, from circles of nearly a foot in diameter, can contract to a ring of one inch in circumference.

Our body contains about four hundred and fifty muscles, which when we consider their wonderful and artificial construction and collocation, and the united advantages of firmness and mobility in the instruments of motion to which they are fixed, bestow on us two endowments of the highest utility and consequence; the greatest agility of the whole body and of individual parts, combined with a wonderful strength and power of enduring continued exertions. Both these prerogatives arise partly from the perfection in the fabric of the muscles themselves; which, as well as the perfect state of the bones and joints, is most conspicuous in the adult stage of life; and partly from exercise and habit, the influence of which in augmenting the extent and celerity of muscular motion is most conspicuous in the feats of the opera and rope dancer, the runner, the boxer, the porter, &c.

Voice and Speech. The voice is a sound resulting from the vibrations which the air suffers during its passage through the glottis, when expelled from the lungs. Speech or articulated voice is produced by this sound modified by the motions of the tongue, lips, and other parts of the mouth. It is obvious, therefore, that no animals can have a voice, unless they possess lungs.

The larynx is the instrument of the voice, of which the rima glottidis is the immediate organ. Hence, if the trachea be opened below, so as to prevent the air from passing through, the voice is destroyed; while, if the opening be made above, the speech only is destroyed.

It is universally agreed among physi-

ologists, that the air, expelled from the lungs in expiration, striking against the sides of the rima glottidis (chordæ vocales) constitutes the voice. But it is necessary that the opening should be placed in some condition produced by an exertion of the will; for although air is constantly passing to and fro, the voice is not formed unless by an express effort for that purpose; neither is it formed during sleep; nor after the muscles of the arytenoid cartilages have been paralysed by dividing their nerves.

The manner in which the voice is changed from acute to grave, and *vice versa*, has been much disputed: whether it arise from dilatation and contraction of the aperture, or from tension and relaxation of the chordæ vocales. On the former supposition the human larynx may be compared to a wind instrument, in which the enlargement of the aperture renders the sound grave, and its diminution acute. By the latter explanation it resembles a stringed instrument. After considering the arguments on both sides, we should be inclined to admit the operation of both causes. The change of the voice from acute to grave at the time of puberty, when the larynx undergoes a remarkable developement, as well as its acuteness in females, whose glottis is less by one third than that of man, shew that the size of the aperture has a great influence. Observing on the other hand that the vocal chords admit of considerable tension and relaxation, we must allow that these variations will render them susceptible of executing, in a given time, vibrations more or less extensive and rapid. And although they are neither dry, stretched, nor isolated, which are necessary conditions to the production of sound in those stringed instruments to which the larynx has been compared, yet they are analogous to vibrating bodies placed at the top of wind instruments, as the reed in hautboys, the mouth-piece in flutes, &c. and equally contribute to the formation and varied inflexions of vocal sound. That all the changes and conditions of the vocal organs, of whatever description, necessary to the production and modification of sounds, are produced by the muscles of the part, is rendered obvious by the elegant experiment, in which the ligature or section of one or both recurrent nerves, or paria vaga, either signally impairs, or entirely destroys, the vocal powers of the animal.

The modifications of the voice are also affected by the length of the trachea; hence the larynx is manifestly drawn up in the neck, in the utterance of acute sounds, and as plainly descends when a grave sound is produced. In singing, where these effects take place in a greater degree, the head is thrown back upon the neck in the former case, and brought forwards on the chest in the latter.

The voice is stronger in proportion to the capacity of the thorax; hence it is weaker after meals, when the stomach, distended by food, prevents the descent of the diaphragm, and in consumptive persons, where the capacity of the lungs is diminished by disease. It acquires more force and intensity, and becomes more sonorous, by its reflections in the mouth and nasal canals. Hence it is disagreeably altered when its passage in this direction is stopped by disease, as by polypus, and it is then commonly, but quite erroneously, said that persons speak through the nose.

Whistling, which is common to man with singing-birds, is produced in the latter by their double larynx; but in the former it is effected by a contraction and corrugation of the lips, in imitation of the effect produced by birds.

In singing, the voice runs through the different degrees of the harmonic scale with more or less rapidity, changing from acute to grave, and *vice versâ*, with an expression of the intermediate notes. It requires much more exertion than speech. The glottis enlarges and contracts, the larynx is elevated or depressed, the neck elongated or shortened, inspirations are accelerated, prolonged, or retarded; expirations are long, or short, and abrupt. The power of singing is peculiar to man, and forms the great prerogative of his vocal organs. Whistling is common also to birds; which are often taught to pronounce words without any great difficulty. On the other hand, parrots are said, in two or three instances, to have been taught, by vast labour, to produce a kind of imitation of singing; but no barbarous tribe has been hitherto met with, which has not been accustomed to employ singing as the natural expression of their feelings and passions.

Speech is a peculiar modification of the voice, formed during the expulsion of the air from the chest, chiefly by means of the tongue, which is applied to the neighbouring parts, as the palate and teeth, assisted by the various motions of the lips. A voice is common to brutes with man; it exists already in the newly-born child, and has

not been entirely wanting in those miserable children who have grown up in a solitary and savage state, or who have been born dumb. Speech results from the enjoyment and cultivation of reason, and is, therefore, like that endowment, a peculiar and distinguishing gift bestowed on man alone. Instinct is sufficient for the purposes of brutes; but man, who does not possess this, or several other assistances, in supporting and defending himself by his own powers, has received the endowments of reason and speech. These have brought him into the social state, which seems to be his natural destination, in which they enable him to utter his ideas and impart his desires to others.

Articulated sounds are represented by letters that express all their powes; and it will be readily admitted that man made a great step towards perfection, when he invented these signs, adapted to preserve and transmit his thoughts. Sounds are expressed by the letters called vowels, which are letters produced by the mere passage of the voice through the mouth; requiring only a greater or less aperture of the mouth. Hence these are the first that the child utters. The consonants, which form the most numerous class of the alphabet, serve to connect the vowels, and are formed by a much more artificial process. These are classed into labial, nasal, oral, and lingual, according to the parts more particularly employed in their pronunciation.

Stammering is a corruption of pronunciation arising from various causes. A tongue too large and thick, diminished power over its actions, as in drunkenness, and unusual length of the frenum belong to this class. Yet sometimes the deficiency does not seem organic; at least, a person who stammers will pronounce perfectly if he speaks slowly; and it may even be entirely overcome by practice and instruction.

Similar causes give rise to lisping. Want of the front teeth will have this effect.

Dumbness may be accidental, or may subsist from birth. In the former case, it arises from organic injury, which affects the mechanism of the parts. In dumbness from birth, deafness seems to be always the cause; so that the absence of speech should here rather be called silence. This, at least, is constantly the case according to the observation of Sicard, on the numerous pupils committed to his care. Here there is an absolute ignorance of sounds, and of their representative value in letters of the alphabet. The vocal organs exhibit no marks of deficiency; they are fit, in short, to fulfil the uses for which nature has destined them, but they remain in a state of inaction because the deaf infant is not conscious that he has the means of communicating his thoughts.

Perhaps the mechanism of *Ventriloquism* is not yet understood. The following quotation from Richerand's Physiology will be sufficient to give the reader an idea of the subject.

"At first I had conjectured that a great portion of the air expelled by expiration did not pass out by the mouth and nostrils, but was swallowed and carried into the stomach, reflected in some part of the digestive canal, and gave rise to a real echo; but after having attentively observed this curious phenomenon, in Mr. Fitz-James, who represents it in its greatest perfection, I was enabled to convince myself that the name ventriloquism is by no means applicable, since the whole of its mechanism consists in a slow, gradual expiration, drawn in such a way that the artist either makes use of the influence exerted by volition over the muscles of the parietes of the thorax, or that he keeps the epiglottis down by the base of the tongue, the apex of which is not carried beyond the dental arches.

"He always makes a strong inspiration just before this long expiration, and thus conveys a considerable mass of air into the lungs, the exit of which he afterwards manages with such address. Therefore repletion of the stomach greatly incommodes the talent of Mr. Fitz-James, by preventing the diaphragm from descending sufficiently to admit of a dilatation of the thorax, in proportion to the quantity of air that the lungs should receive. By accelerating, or retarding, the exit of the air, he can imitate different voices, and induce his auditors to a belief that the interlocutors of a dialogue, which is kept up by himself alone, are placed at different distances; and this illusion is the more complete in proportion to the perfection of his peculiar talent. No man possesses, to such a degree as Mr. Fitz-James, the art of deceiving persons who are least liable to delusion: he can carry his execution to five or six different tones, pass rapidly from one to another, as be does when representing an animated dispute in the midst of a popular assembly."

On the subject of the *Generative Functions*, we have very little to add to what

the reader will find under the articles ANATOMY, COMPARATIVE ANATOMY, and FŒTUS.

The bodies of the male and female present very obvious differences in appearance and character, which have been ascribed to the influence of the generative organs upon the constitution. The removal of the testes in the male, prevents those changes in the beard and voice, at the time of puberty, which would otherwise occur; and eunuchs even approach in other respects to the female character, as in the breadth and projection of the hips. Again, in some remarkable cases, where the organs of the female have been wanting, or mal-formed, similar effects have taken place in the constitution; so that there is some reason for saying with Van Helmont, *propter solum uterum mulier est, id quod est.*

Hermaphrodism, or the union of both sexes in the same individual, is impossible in man and the warm-blooded animals. All the supposed hermaphrodites hitherto examined were mal-formed beings, whose male organs were imperfect, or the female apparatus too prominent, so as to render the sex doubtful. No one has shown himself capable of impregnating his own person, so as to produce a being like himself; indeed, in most instances they were incapable of assisting in reproduction, as an imperfection of the organs employed for that purpose condemned them to sterility.

Man presents a peculiarity, in not being subject to the influence of the seasons in the exercise of his generative functions; while other animals cohabit at fixed periods and certain times of the year, and afterwards seem to forget the pleasures of love to satisfy other wants.

Conception. Physiologists have not hitherto succeeded in explaining the mechanism of that elongated and distended state of the penis, occurring under the irritation of the sexual passion, which adapts the organ to the performance of its natural functions. The obvious circumstances are, that the cells of the corpus spongiosum urethræ, and corpora cavernosa penis, are distended to the utmost with blood, poured into them from the arteries much faster than it can be, or at least is returned by the veins. The irritation, which affects the penis, extends to the internal parts. The secretion of the testes becomes more active, and these bodies are drawn up towards the abdomen; the vesiculæ seminales, and the ducts of the prostate, also pour out their contents into the urethra. The semen is a mixed fluid, derived from the three sources just mentioned; but the smallest part probably comes from the testes. The most remarkable circumstance in this fluid is, that it contains numerous microscopic animalcula, with a round head and slender tail, moving about with rapidity.

The prolific liquor is expelled from the penis by a spasmodic action of the accelerator urinæ muscle: the whole body seems to participate in the same convulsive state, and the instant of ejaculation is marked by an orgasm through every part. It seems that nature has forgotten, for the moment, every other function, and is totally occupied in collecting her powers, and directing them towards the same point. Hence an universal languor follows this general convulsion, and hence the old observation, *omne animal post coitum triste.*

The seminal liquor, thus propelled into the generative organs of the female, is supposed to pass through the uterus and fallopian tubes, and to come into actual contact with the ovaria. The closeness of the mouth, and indeed of the whole cavity of the uterus, together with the very small calibre of the fallopian tube, especially at its origin in the uterus, (where it will only admit a bristle) are difficulties in the way of this explanation, which have led to the opinion, that the semen itself does not penetrate into the uterus, but that an exhalation, or *aura seminalis*, comes into contact with the germs, and is sufficient for their fecundation. This is opposed by the experiments of Spallanzani and others, in which the ova of frogs were readily impregnated by contact of the seminal fluid, but were not at all affected by the vapour or aura.

The attachment of the fimbriæ of the tube to the ovarium, which experiment has shown to occur during coition, establishes an uninterrupted canal from the uterus to the ovarium, and prevents the semen from becoming diffused in the abdomen.

The germ of the future being pre-exists in the ovarium, where it is formed by a peculiar action of the part, in short, by a true secretion. This germ, in its original state, is a small vesicle of fluid, first noticed by De Graaf, whence the term of ovula Graafiana, applied to their appearance in the virgin ovary. Here we do not mean to countenance those doctrines of evolution which suppose, that generation only developes germs that have existed from the beginning of the world. We suppose, that the ova

produced by the elaboration of blood, carried to the ovaria by the spermatic vessels, contain the rudiments of the new beings. But the germs in that state are inert, and require that the seminal spirit should be employed to rouse them from their inactivity. In birds and reptiles the formation of the germ by the female is incontestible; it is not quite so obvious in the class of mammalia; but we infer it here from analogy, and also from the experiment of Mr. Hunter, in which the removal of one ovarium from a sow, diminished in a remarkable degree the number of young produced.

Fœtal Existence. This is purely vegetative. The fœtus receives the fluids brought by the vessels of the mother to the placenta for its growth and nourishment. It may be considered as a new organ, the produce of conception, participating in the general life, but possessing a vitality peculiar to itself, and, to a certain degree, independent of that of the mother. To say that it is asleep is erroneous; for not only are the organs of sense and voluntary motion in a state of perfect repose, but also several of the assimilating functions are totally unemployed, as digestion, respiration, and the generality of the secretions. The fœtus, however, performs spontaneous motions, which accoucheurs enumerate among the signs of pregnancy. It is nourished, like every other organ, by appropriating to itself whatever is found in the blood, brought by the vessels of the uterus proper for its purpose; and the interception of this fluid by the ligature, or compression of the umbilical chord, occasions death.

Suckling. The close sympathy between the uterus and breasts is so obvious, as to attract the notice of every observer. Both these organs are developed at the same period of life, and cease together to perform their functions, when the female becomes incapable of contributing towards the continuation of the species. The breasts increase in size during pregnancy, but are never more swelled than after parturition. The infant applies its mouth to the nipple, and sucks; *i. e.* forms a vacuum by inspiring, in consequence of which the atmospheric pressure forces the milk through the lactiferous tubes into its mouth. The nipple experiences a vascular turgescence, or kind of erection; which also affects the excretory tubes of the mammary gland, so as to cause them sometimes to expel the fluid to some distance by jets. The structure of the breast is explained under the article MAMMARY GLAND, and the composition of their secretion under MILK.

Ages, Temperaments, &c. Having thus gone through the animal economy, according to its distribution into particular functions, we shall just contemplate man in a general view, passing through the whole course of his existence, and note the principal epochas of his life, from its commencement to the termination in death.

The first perceptible traces of the fœtus occur about three months after conception. It is then animated by a very slight kind of vegetable life, and possesses true blood, and motion of the heart about the fourth week. The latter, as observed in the chicken, has been named, from the time of Aristotle, *punctum saliens.* The formation of the bones commences about the seventh or eighth week. The earthy particles are first deposited in nuclei in the clavicles, ribs, vertebræ, larger cylindrical bones of the extremities, lower jaw, and face: a very delicate network is also seen in some of the bones of the cranium.

As a general observation, it may be affirmed, that the growth of the embryo, as well as of the child, both before and after birth, is more rapid in proportion as it is younger.

About the middle of pregnancy, the operation of some vital functions is discerned: the secretion of fat and bile commences. At a more advanced period of utero-gestation, the scalp is covered with a short and delicate hair; the nails are formed; the membrana pupillaris destroyed; the external ear becomes firmer and more elastic; and the testes descend.

Besides the important changes in the whole economy which follow parturition, there are certain alterations in the external habit of the body. The down which covers the face at birth disappears; the rugæ of the skin are obliterated; the anus becomes hidden between the buttocks, which are now gradually formed.

The infant gradually brings into action the faculties of the mind. It perceives and attends to external objects, remembers, desires, &c. It smiles in the second month, and seems to dream at no great length of time after birth. The organs of sense become more complete in their formation. The bones of the skull become stronger, and the fontanells are diminished. Dentition commences about the eighth month. The infant may then be weaned, as his teeth enable him to commence the use of more so-

lid food. About the end of the first year he learns to stand on his feet, and to assume the erect posture, that most distinguishing attribute of the human body.

When it has now been removed from the breast, and learned the use of the lower limbs, its powers and independence increase daily, and receive a vast accession from the developement of another peculiar privilege of the human subject, the enjoyment of speech; by which the tongue, under the direction of the mind, pronounces those ideas which are now become familiar.

At the seventh year the twenty milk teeth begin to fall out, and are succeeded in a gradual progress during the following years by the thirty-two permanent teeth. At this time the memory excels all the other faculties of the mind; whereas about the fifteenth year the powers of imagination begin to prevail. This is the time of puberty, in which the human subject is gradually prepared, by various important changes, for the exercise of the sexual functions. The breasts enlarge in the female, the chin becomes covered with hair in the male, and other similar signs of puberty are noticed in both sexes. The menstrual discharge commences in the softer sex; and this important era in the economy of the female is marked by an increased expression in the eyes, and redness of the lips, and more manifest sensible qualities in the matter of perspiration. The seminal secretion becomes active in the male, attended with an increase of the beard, and a deepening of the voice consequent on a remarkable developement of the larynx. The internal and spontaneous calls of nature now rouze the sexual instinct, for the exertion of which both sexes are prepared.

No definite and precise period can be assigned for the changes which constitute puberty: it varies according to climate and temperament. It is more early in the female than in the male; but in this climate girls may be said to attain it at the age of fourteen or fifteen, and men at seventeen or eighteen. Soon after these periods the growth of the body is completed; the stature of which varies much in different races, not to mention its varieties in individuals and families. The epiphyses, which have hitherto been distinct from the body of the bone, are now completely consolidated with it.

Virility, *Manhood*, or *Adult Age*, begins from the twenty-first to the twenty-fifth year. If the increase of the body in height have ceased at this time, it grows in other dimensions. The organs become firm and consistent; their functions are performed with vigour; the intellectual and moral faculties are perfected; and the dominion of the judgment succeeds that of the imagination. This period, which is called that of mature age, extends to the fiftieth or fifty-fifth year in men, but not much beyond the forty-fifth in women, in whom it begins earlier. During this long interval men enjoy all the plenitude of their existence.

Temperaments. As the characters of the human species are now fixed with stability, we may sketch the differences which mark individuals. Health, in the explanation of which all physiology is concerned, consists in such a harmony and equilibrium of the material fabric of the body, and of its animating powers, as is necessary for the performance of the various functions. It requires, therefore, fluids rightly prepared; solids duly formed from these; the latter thoroughly animated by their vital powers; and, lastly, a sound mind in this healthy body. These four principles are constantly acting and re-acting in the human body. The fluids act as stimuli on the solids; which possess vital powers, enabling them to re-ceive those stimuli, and to re-act. The connection of the mind and body is not discerned merely in the influence of the will, in what physiologists call voluntary actions; since the affections of the body clearly act on the mind in many other ways than through the medium of sensual perceptions. The infinitely varied modifications, which the four principles admit of, show immediately with what latitude our notions concerning health should be formed. Hence arises the distinction of temperaments; that is, the different manner in which the living solid is affected by stimuli, particularly of the mental class, the different aptitude for such impressions, and the greater or less facility with which these stimuli may themselves be excited. There is such great variety of degrees and combinations of temperaments, that a wide field is open for those who wish to employ themselves in dividing and arranging them. The common division is sufficient for our purpose; it comprehends the sanguineous, which is very easily but slightly affected by stimuli; the choleric, which is easily and strongly excited; the melancholic, which is slowly but deeply moved; and the phlegmatic, which is the slowest of all

in admitting the impressions of exciting causes. Together with these distinctions, there are numerous differences of bodily formation, of diversity in the proportion and connection of parts, as well as in the energy relative to certain organs, accompanying each temperament, which cannot be particularized here, without entering too much into detail.

Each individual has a particular manner of being, which distinguishes his temperament from that of every other, to which, notwithstanding, it may bear a very strong resemblance. These individual temperaments, the knowledge of which is of no small importance in the practice of physic, are called idio-syncrasies.

There are many both predisposing and occasional causes, which have an operation in producing this diversity of temperaments: as hereditary disposition, habit of body, climate, diet, religion, culture, luxury, &c.

For the account of the various races of mankind, see the article MAN.

Advanced Age and Decay. Cessation of the menses in women, which is occasionally accompanied by the production of a beard; an indisposition to venery in the male sex; and, in both, a peculiar dryness, and sensible decrease in the vital powers, are the signs of approaching old age. The body now diminishes, and loses the power it had acquired; the decrease following the same progression as the growth, and occupying about the same space of time, when no accident hastens the approach of death. The whole volume of the body diminishes, the skin wrinkles, particularly in the forehead and face; the hair turns grey, and organic action becomes languid.

The decay of the body is evidenced by an increasing dulness both of the external and internal senses, necessity of longer sleep, and general torpor of all the functions. The hair grows white, and falls off, the teeth drop from their sockets, the cartilages ossify, all the organs become hard, and the fibres more dry and contracted. The head is no longer supported by the neck, nor can the legs sustain the trunk; nay, the bones themselves, the foundations of the machine, partake of the general decay. On these phenomena we may observe, that the animal or exterior life ceases first: the senses fail in succession, and then the functions of the brain cease. The cessation of the locomotive and vocal powers follows as a necessary consequence. Here, then, the old man is dead to all surrounding objects, but his organic life still subsists; so that this state is analogous to that of uterine existence, where the life is nearly of the vegetable kind. Thus, the body gradually dies, life is extinguished by successive shades, and death is only the last term in this succession of degrees. We arrive now at the conclusion of physiology; *death without disease*, which is the object of all medicine, and the causes of which are necessary and inevitable. It is no more possible for us to avert the fatal term, than to change the laws of nature.

The phenomena of death consist in a coldness of the extremities, gradually mounting to the trunk; dimness of the eye; feeble, slow, and irregular pulse; respiration performed at longer intervals, and terminated at last by a strong expiration. In experiments on animals, a struggle is observed about the heart, and the right ventricle and auricle are found to survive the opposite cavities for a short time. That death has taken place is shown by coldness of the body, combined with rigidity; flaccidity of the cornea, relaxed state of the anus, lividity of the back, and a certain cadaverous odour. When all these circumstances are combined, there will scarcely be any opportunity for remarking the uncertainty of the signs of death.

Although the weakness of the thread of life in its early stages, the intemperance of manhood, the power of disease and of accident, exert such destructive effects on the human race, that out of one thousand children born into the world, not more than seventy-eight die as we have now described, without disease; yet on comparing the longevity of man with that of other mammalia, under nearly similar circumstances, we shall be immediately convinced, that, of all the querulous declamations concerning the wretchedness of human life, none is more unjust than the complaint of its shortness.

Putrefaction. As soon as life abandons the organs, they become totally influenced by physical laws; and their component parts have a tendency to separate from each other; which is stronger in proportion to the multiplicity of their elements. The entire cessation of life is necessary to this change, for life and putrefaction are two ideas absolutely contradictory of each other. A mild temperature, humidity, and the presence of air, are necessary to putrefaction. Icy coldness, or great heat, prevent it: the former by condensing the parts, the lat-

ter by depriving them of moisture. Air is not essential, as bodies will decay in vacuo.

All animal substances exhale at first a musty or cadaverous odour, soften, increase in size, become heated, change their colour, turn green, blue, and, lastly, a blackish brown. Several gaseous matters are at the same time disengaged, among which the ammoniacal is the principal, both on account of its quantity, and because animal matter begins to furnish it, from the instant its alteration commences to the period of its complete dissolution. Carbonic acid gas is also disengaged, and forms with the ammoniacal air a fixed salt. Hydrogen, united with phosphorus, sulphur, azote, and carbon, and all things that can result from their respective combinations, are likewise produced.

Putrefaction, considered in a philosophical point of view, is only the method employed by nature to return our organs, that are deprived of life to a more simple composition, in order that their elements may be employed for new creations *(Circulus æterni motus)*. Nothing is, therefore, better proved than the metempsychosis of matter; whence we may conclude, that this doctrine, like most of the tenets and fabulous conceptions of antiquity, is only a mysterious veil dextrously interposed between nature and the vulgar by the hand of philosophy.

PHYSSOPHORA, in natural history, a genus of the Vermes Mollusca class and order. Generic character: body gelatinous, pendant from the aerial vesicle, with gelatinous sessile members at the sides, and numerous tentacula beneath. There are three species, *viz.* the hydrostatica, which is of an oval shape; the rosacea, which is orbicular; and the filiformes, which is lateral, filiform, and pendent. This genus is nearly allied to the MEDUSA tribe, which see.

PHYTEUMA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: corolla wheel-shaped with linear segments, five-parted; stigma bifid or trifid; capsule two or three-celled, inferior. There are sixteen species. The European sorts of phyteuma have the flowers in a close terminating head; those from the East have them scattered; in all there is a little bracte to each flower. They are all natives of the South of Europe.

PHYTOLACCA, in botany, a genus of the Decandria Decagynia class and order. Natural order of Miscellaneæ. Atriplices, Jussieu. Essential character: calyx none; petals five, calycine; berry superior, ten-celled, ten-seeded. There are six species.

PHYTOLOGY, a discourse concerning the kinds and virtues of plants.

PHYTOTOMA, the *plant-cutter*, in natural history, a genus of birds of the order Passeres. Generic character: bill conic, straight, and serrated on the edges; nostrils oval; tongue obtuse and short. There are two species.

P. rara, or the plant cutter of Chili, inhabits that country in great plenty, and is about the size of a quail, and feeds on vegetables. These birds take considerable pains to saw off the vegetable as near as possible to the ground, and are extremely injurious in the cultivated lands of the districts which it frequents, and are consequently particularly disliked by the inhabitants. They build in high trees and sequestered situations. They are distinguished by having four toes from the following species, which has only three: P. tridactyla, the Abyssinian plant cutter. This is of the size of a grosbeak, delights in solitude, and abounds in the wilds of Abyssinia, where it subsists much on the kernels of the almond, breaking the shell with particular ease and dexterity.

PICÆ, in natural history, the second order of the class Aves in the Linnæan system, They are characterised by a sharp-edged bill, convex above; legs short, strong; feet formed for walking, perching or climbing; body toughish, impure. They feed on various filthy substances. They build their nests in trees; the male feeds the female while she is sitting; they live in pairs. There are twenty-six genera divided into sections.

A. Feet formed for perching, containing:

Buphaga	Oriolus
Certhia	Paradisea
Coracias	Sitta
Corvus	Trochilus
Glaucopis	Upupa
Gracula	

B. Feet formed for climbing, containing:

Bucco	Psittacus
Crotophaga	Rhamphastos
Cuculus	Scythrops
Galbula	Trogon
Picus	Yunx

long, and strikes with far greater comparative force against the trees than any of the tribe. It creeps with facility over the branches in every direction, and when any person attempts to observe it on one side of a branch passes to the opposite with extreme celerity, repeating this change in correspondence with every renewed effort of the enemy. For the greater spotted woodpecker, see Aves, Plate XII. fig. 3.

PIECE, in commerce, signifies sometimes a whole, and sometimes a part of the whole. In the first sense, we say a piece of cloth or velvet, &c. meaning a certain quantity of yards regulated by custom; being yet entire, and not cut. In the other signification we say a piece of tapestry; meaning a distinct member wrought apart, which, with several others, make one hanging.

Piece, in matters of money, signifies sometimes the same thing with species: and sometimes by adding the value of the pieces, it is used to express such as have no other particular name.

Piece, in heraldry, denotes an ordinary or charge. See Ordinary and Charge. The honourable pieces of the shield are the chief, fesse, bend, pale, bar, cross, saltier, chevron, and in general all those which may take up one-third of the field, when alone, and in what manner soever it be.

Pieces, in the military art, include all sorts of great guns and mortars. Battering pieces are the larger sort of guns used at sieges for making the breaches, such are the twenty-four pounder, and culverin, the one carrying twenty-four, and the other an eighteen pound ball. Field pieces are twelve-pounders, demiculverins, six-pounders, sakers, minions, and three-pounders, which march with the army, and encamp always behind the second line, but in the day of battle are in the front. A soldier's firelock is likewise called his piece.

PIEPOWDER is a court held for the redress of grievances, in remedying and inforcing of contracts at fairs.

PIER, or Peer, in building, denotes a mass of stone, &c. opposed by way of fortress against the force of the sea, or a great river, for the security of ships that lie at harbour in any haven.

PIERCED, or Percé, in heraldry, is when any ordinary is perforated, or struck through, showing, as it were, a hole in it, which must be expressed in blazon, as to its shape: thus if a cross have a square hole, or perforation in the centre, it is blazoned square-pierced, which is more proper than quarterly-pierced, as Leigh expresses it. When the hole or perforation is round, it must be expressed round-pierced; if it be in the shape of a lozenge, it is expressed pierced lozenge-ways. All piercings must be of the colour of the field, and when such figures appear on the centre of a cross, &c. of another colour, the cross is not to be supposed pierced, but that the figure on it is a charge, and must be accordingly blazoned.

PIGEON. See Columba.

Pigeons. By statute 1, James I. c. 27. the shooting at a pigeon is punishable with 20*l.* fine, or commitment for three months.

PIGMENTS, are preparations, in a solid form, chiefly employed by painters, for imitating particular colours, and imparting them to the surface of bodies. They are obtained from animal, vegetable, and mineral substances: the latter are the most durable. See Colours.

PIKE, an offensive weapon, consisting of a shaft of wood, twelve or fourteen feet long, headed with a flat-pointed steel, called the spear. The pike was a long time in use among the infantry, to enable them to sustain the attack of the cavalry, but it is now taken from them, and the bayonet, which fixes on at the end of the carbine, is substituted in its place. Yet the pike still continues the weapon of the serjeants, who fight pike in hand, salute with the pike, &c.

PILASTER, in architecture, a square column, sometimes insulated, but more frequently let within a wall, and only showing a fourth or fifth part of its thickness. See Architecture.

PILCHARD, a species of the Clupea, or Herring genus. The pilchard is less than the herring, but fatter and more abundant in oil. The pilchard appears in vast shoals off the Cornish coasts, about the middle of July. Their approach is known by much the same signs as those that indicate the arrival of the herring. To the inhabitants of Cornwall, the pilchard fishery is a very profitable concern. Thousands of persons are employed, during the season, in catching and curing the fish; and the fishermen and merchants make large gains in sending them to Italy, Spain, &c. Nearly 30,000 hogsheads are exported annually.

PILE, any heap, as a pile of balls, shells, &c.

Pile, in antiquity, a pyramid built of

wood, on which the bodies of the deceased were laid in order to be burnt.

PILE, in coinage, denotes a kind of puncheon, which in the old way of coining with the hammer, contained the arms, or other figure and inscription to be struck on the coin. Accordingly we still call the arms side of a piece of money the pile, and the head the cross, because in ancient coin, a cross usually took the place of the head in ours: but some will have it called pile, from the impression of a church built on piles, struck on this side our ancient coins, and others will have it to come from *pile*, the old French word for a ship.

PILE, in heraldry, an ordinary in form of a wedge, contracting from the chief, and terminating in a point towards the bottom of the shield. The pile, like other ordinaries, is borne inverted, ingrailed, &c. and issues indifferently from any point of the verge of an escutcheon.

PILE *engine*. See ENGINE.

PILE, in military affairs. Piles of shot or shells, are generally formed in the King's magazines, in three different manners: the base is either a triangular square, or a rectangle; and from thence the piles are called triangular, square, and oblong.

Rules for finding the Number of Shot in any Pile.

PILE, *triangular*. Multiply the number in the side of the base by the base + 1, this product by the base + 2, and divide by 6.

PILE, *square*. Multiply the bottom row by the bottom row + 1, and this product by twice the bottom row + 2, and divide by 6.

PILES, *rectangular*. Multiply the breadth of the base by itself + 1, and this product by three times the difference between the length and breadth of the base, added to twice the breadth + 1, and divide by 6.

PILES, *incomplete*. Incomplete piles being only frustrums, wanting a similar small pile on the top, compute first the whole pile as if complete, and also the small pile wanting at top; and then subtract the one number from the other.

PILEUS, in botany, the orbicular horizontal expansion, or upper part of a mushroom, which covers the fructification. This, from its figure, is termed, by botanists, the hat of the mushroom.

PILL. See PHARMACY.

PILLAR, in architecture, a kind of irregular column, round and insulated, but deviating from the proportions of a just column. See ARCHITECTURE.

PILLORY, was anciently a post erected in a cross road, by the Lord of the Manor, with his arms upon it, as a mark of his seignory, and sometimes with a collar to fix criminals to. At present, it is a wooden machine, made to confine the head and hands, in order to expose criminals to public view, and to render them publicly infamous.

PILOCARPOS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx five-leaved; corolla five-petalled; filaments inserted below the germ; pericarpium with from two to five cocculi, united below, elastic. There is only one species, *viz.* P. racemosus, a native of the West Indies.

PILOT, a person employed to conduct ships over bars and sands, or through intricate channels, into a road or harbour. Pilots are no constant and standing officers aboard our vessels, but are called in occasionally, on coasts or shores unknown to the Master, and having piloted in the vessel, they return to the shore where they reside.

Every respect and attention are paid to pilots on board his Majesty's ships: they are likewise well accommodated, and when conducting a ship have the sole command of it, and may give orders for steering, setting, trimming, &c. The captain is to see that all the officers and men obey his orders.

PILOT. All pilots must be examined and approved by the Trinity House. 3 Geo. I. c. 13. And for the particular regulations of the pilots of the Trinity House, at Deptford, see the statute 5 Geo. II. c. 30.

PILULARIA, in botany, a genus of the Cryptogamia Miscellaneæ class and order. Natural order of Filices, or Ferns. Generic character: common receptacle globose, with four cells and four valves, lined with numerous anthers, and many globose germs beneath them. There is but one species, *viz.* P. globulifera, pill-wort, or pepper-grass.

PIMELEA, in botany, a genus of the Diandria Monogynia class and order. Essential character: calyx none; corolla four-cleft; stamina inserted into the throat; nut covered with a bark, one-celled. There are four species, natives of New Zealand, and New South Wales.

PIMELIA, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform; feelers four;

thorax plano-convex, margined; head exserted; shells rather rigid; generally without wings. There are between one and two hundred species, divided into sections: A. antennæ, moniliform at the tip. B. antennæ, entirely filiform. The section is subdivided into *a* feelers filiform, and *b* feelers clavate. The section B is likewise subdivided into *a*, fore-feelers, filiform: *b*, fore-feelers, hatchet-shaped; hind ones clavate. The species P. mortisaga, is black; shells mucronate, subpunctured. It is found in many parts of Europe; and in Sweden it is regarded as a presage of death to one of the house in which it is found crawling.

PIMPINELLA, in botany, *burnet saxifrage*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: petals bent in; stigma subglobular; fruit ovate, oblong. There are nine species, among which we shall notice the P. anisum, anise, it has an annual root, producing a stem a foot and half in height, dividing into several branches, having narrow leaves on them, cut into three or four narrow segments; umbels large and loose, on long peduncles; flowers small, yellowish white; seeds oblong, swelling, possessing an aromatic scent, and a pleasant warm taste: in distillation with water, three pounds of them yield an ounce of essential oil, which congeals into a butyraceous white concrete, even when the air is not sensibly cold; these seeds also yield an oil, by expression, of a greenish colour and grateful taste, strongly impregnated with the flavour of the seeds. It is a native of Egypt; it is cultivated in Malta and Spain, whence the seeds are annually imported into England.

PIN, in commerce, a little necessary implement made of brass-wire, used chiefly by the women in adjusting their dress. The perfection of pins consists in the stiffness of the wire and its whiteness, in the heads being well turned, and in the fineness of the points. The London pointing and whitening are in most repute, because our pinmakers, in pointing, use two steel mills, the first of which forms the point, and the latter takes off all irregularities, and renders it smooth, and as it were polished; and in whitening, they use block-tin granulated: whereas in other countries they are said to use a mixture of tin, lead, and quicksilver; which not only whitens worse than the former, but is also dangerous on account of the ill quality of that mixture, which renders a puncture with a pin thus whitened, somewhat difficult to be cured. The consumption of pins is incredible, and there is no commodity sold cheaper. The number of hands employed in this manufacture is very great, each pin passing through the hands of six different workmen, between the drawing of the brass wire, and the sticking of the pin in the paper.

Pins are sometimes made of iron wire, rendered black by a varnish of linseed-oil, with lamp-black, which the brass-wire would not receive: these are designed for the use of persons in mourning, though not universally approved.

PINCHBECK. See COPPER.

PINE. See PINUS.

PINE *apple*. See ANANAS.

PINEAL GLAND. See ANATOMY.

PINGUICULA in botany, *butter wort*, a genus of the Diandria Monogynia class and order. Natural order of Corydales. Lysimachiæ, Jussieu. Essential character: corrola ringent, with a spur; calyx, two-lipped, five-cleft; capsule, one celled. There are five species, natives of many parts of England.

PINION, in mechanics, an arbor, or spindle, in the body whereof are several notches, which catch the teeth of a wheel that serves to turn it round: or it is a lesser wheel which plays in the teeth of a larger. In a watch, &c. the notches of a pinion, which are commonly 4, 5, 6, 8, &c. are called leaves, and not teeth, as in other wheels. For the pinions of a watch, and the leaves, turns, &c. thereof. See CLOCK.

PINION *of report*, is that pinion in a watch, commonly fixed on the arbor of a great wheel; it drives the dial-wheel, and carries about the hand.

PINITE, in mineralogy, is of a blackish grey colour, usually crystallized, in six-sided prisms with truncated edges and angles. The crystals are of different sizes. Specific gravity almost three. It experiences no alteration before the blow-pipe, either alone or with the addition of borax. With carbonate of soda it forms an opaque globule, and with microcosmic salt, a transparent glass: it is compounded of

Alumina	63.75
Silica	29.50
Oxide of iron	6.75
	100.00

It has been found only in the mine level of Pini in Saxony, hence it derives its name; and is usually accompanied with quartz, felspar and mica.

PINK, a vessel used at sea, masted and rigged like other ships, only that this is built with a round stern; the bends and ribs compassing so as that her ribs bulge out very much. This disposition renders the pinks difficult to be boarded, and also enables them to carry greater burthens than others, whence they are often used for store-ships, and hospital-ships in the fleet.

PINK. See DIANTHUS.

PINNA, in natural history, *nacre*, a genus of the Vermes Testacea class and order: animal a limax: shell bivalve, fragile, upright, gaping at one end, and furnished with a beard; hinge without teeth, the valves united into one. There are eighteen species. The inhabitants of these shells produce a large quantity of byssus, which is woven by the Italians into a kind of silk: the shells themselves are generally found standing erect in the smoother waters of the bays, with the larger end a little open: the fish of several of the species affords a rich food.

PINNACE, a small vessel used at sea, with a square stern, having sails and oars, and carrying three masts, chiefly used as a scout for intelligence, and for landing of men, &c. One of the boats belonging to a great man of war, serving to carry the officers to and from the shore, is also called the pinnace.

PINNACLE, in architecture, the top or roof of an house, terminated in a point. This kind of roof, among the ancients, was appropriated to temples; their ordinary roofs were all flat, or made in the platform way. It was from the pinnacle that the form of the pediment took its rise.

PINNATED *leaves*. See BOTANY.

PINT, a vessel or measure used in estimating the quantity of liquids, and even sometimes of dry things. It is the eighth part of a gallon, both in ale and wine measure; but the gallon being different, the pint must also differ. The wine pint of pure water weighs almost seventeen ounces avoirdupois, and the ale pint contains a little more than twenty ounces. The Scotch pint is equal to three English pints.

PINUS, in botany, *pine tree*, a genus of the Monoecia Monadelphia class and order. Natural order of Coniferæ. Essential character: male, calyx four-leaved; corolla none; stamina very many, with naked anthers: female, calyx strobiles, with a two-flowered scale; corolla none; pistil one; nut with a membranaceous wing. There are twenty-one species; we shall notice some of the most remarkable.

P. cedrus, cedar of Lebanon, has a general striking character of growth so peculiar to itself, that no other tree can be mistaken for it; it is placed by Linnæus along with the larch, in the same genus with the firs and pines; it agrees with the former in its foliation, with the latter in being evergreen; the leaves resemble those of the larch, but are longer and closer set, erect, and perpetually green; the cones are tacked and ranged between the branch leaves, in such order as to give it an artificial and very curious appearance, and at a little distance a beautiful effect; these cones have the bases rounder, or rather thicker, and with blunter points, the whole circumzoned with broad, thick scales, which adhere together in exact series to the summit, where they are smaller; but the entire lorication is smoother couched than those of the firs: within these repositories, under the scale, nestle the small nutting seeds, of a pear shape. Many wonderful properties are ascribed to the wood of this celebrated tree, such as its resisting putrefaction, destroying noxious insects, continuing a thousand or two thousand years sound, yielding an oil famous for preserving books and writings.

The P. sylvestris, wild pine tree, is called in Britain the Scotch fir, from its growing naturally in the mountains of Scotland; it is common in most parts of Europe, particularly the northern; the wood is the red or yellow deal, which is the most durable of any of the kinds yet known; the cones are small, pyramidal, ending in narrow points; they are of a light colour; the seeds are small. In a favourable soil, this tree grows to the height of eighty feet, with a straight trunk; the bark is of a brownish colour, full of crevices; the leaves issue from a white, truncated, little sheath, in pairs; they are linear, acuminate, entire, striated, convex on one side, flat on the other, mucronate, bright green, smooth, from an inch and a half to two inches in length; the scales of the male catkins roll back at top, and are feathered; the inner and upper scales of the cones gradually terminate in a short awn, the lower scales have none. Few trees have been applied to more uses than this; the tallest and straightest afford masts to our navy; the timber is resinous, durable, and applicable to numberless domestic purposes; from the trunk and branches of this and others of the genus, tar and pitch are obtained; by inci-

sion, barras, Burgundy pitch, and turpentine are acquired and prepared; the resinous roots are dug out of the ground in many parts of the Highlands of Scotland. The fishermen make ropes of the inner bark; and hard necessity has taught the Laplanders and Kamschatdales to convert it into bread; to effect this, in spring they strip off the outer bark carefully from the best trees, collecting the soft, white, succulent, interior bark, and drying it in the shade. When they have occasion to use it, they first toast it at the fire, then grind, and after steeping the flower in warm water, to take off the resinous taste, they make it into thin cakes and bake them.

P. strobus, Weymouth pine tree, or white pine, is one of the tallest species, frequently attaining a hundred feet in height, in its native country, North America. The bark is very smooth and delicate, especially when the tree is young; the leaves are long and slender; they are closely placed on the branches; the cones are long, slender, and very loose, opening with the first warmth of the spring.

P. picea, silver fir, is a noble, upright tree; the branches are not numerous, but the bark is smooth and delicate; the upper surface of the leaves is of a fine strong green, the under has two white lines running lengthwise on each side of the midrib, giving the leaves a silvery look, for which reason this fir takes its name; the cones are large, growing erect; when the warm weather comes on they soon shed their seeds; the scales are wide, deltoid, rounded above, below beaked, and appendicled with a membranaceous, spatulate, dorsal ligule, terminated by a recurved dagger-point; nuts rather large, membranaceous, variously angular, dun-coloured. It has been observed in Ireland, that no tree grows so speedily to so large a size as the silver fir; some at forty years' growth, in a wet clay on a rock, measuring twelve feet in circumference at the ground, and seven feet and a half at five feet high; one contained seventy-six feet of solid timber.

P. balsamea, balm of Gilead fir tree, rises with an upright stem; the leaves are dark green on their upper surface, marked with whitish lines underneath; the cones are roundish and small; the buds and leaves are remarkably fragrant; from wounds made in this tree a very fine turpentine is obtained, which is often sold for the true balm of Gilead. This tree makes little progress after eight or ten years' growth; it has very much the habit of the silver fir; but the leaves are wider and blunter, disposed on each side along the branches like the teeth of a comb, but in a double row, the upper one shorter than the under; underneath they are marked with a double, glaucous line, each having eight rows of white dots; they are often cloven at top.

PIONEER, in the art of war, a labourer employed in an army to smooth the roads, pass the artillery along, and dig lines and trenches, mines, and other works.

PIPE, in building, &c. a canal or conduit, for the conveyance of water and other liquids. Pipes for water, water-engines, are usually of lead, iron, earth, or wood: the latter are usually made of oak or elder. Those of iron are cast in forges, their usual length is about two feet and a half; several of these are commonly fastened together, by means of four screws at each end, with leather or old hat between them, to stop the water. Those of earth are made by the potters; these are fitted into one another, one end being always made wider than the other. To join them the closer, and prevent their breaking, they are covered with tow and pitch: their length is usually about that of the iron pipes. The wooden pipes are trees bored with large iron augers, of different sizes, beginning with a less, and then proceeding with a larger successively; the first being pointed, the rest being formed like spoons, increasing in diameter, from one to six inches or more: they are fitted into the extremities of each other.

Wooden pipes are bored as follows. (Fig. 1, Plate Pipe-boring,) is a plan of the machine; and fig. 2, an elevation of it. The piece of timber intended to form the pipe, is placed upon a frame, *a, a, a, a*, and held down upon it firmly by chains going over it, and round two small windlasses, *b b*, and it is wedged up to prevent its rolling sideways; if the piece is tolerably straight this will be sufficient, otherwise it must be steadied by iron dogs or hooks, similar to those used by sawyers, drove into the carriage at one end, and into the tree at the other. The frame and tree together run upon small wheels traversing two long beams or ground sills, D D, placed on each side of a pit, dug to receive the chips made by the borer; at one end they are connected by a cross beam, E, bolted upon them, this supports the bearing for a shaft, F, the extremity of which, beyond the bearing, is perforated at the end with a square hole, to receive the end of the borer, *f*. The car-

riage, *a a*, and piece of timber, are advanced towards the borer by ropes; *g* is one hooked to it, going over a pulley, (not seen) and returning to a windlass, H, above the carriage, round which it is coiled several times, and the end made fast to it; *h* is another rope, hooked to it at the other end, and going over a pulley, and, coming to the same windlass, H, it is coiled round the windlass in a contrary direction to *g g*, and then nailed fast; by this means, when the windlass, H, is turned by the handles on its wheel, I; one rope will wind up, while the other gives out, and draws the carriage and piece of timber backwards or forwards, according as the wheel is turned. The weight of the borer is supported by a wheel, *l*, turning between uprights, fixed to a block, L, whose end rests upon the groundsills, D; it is moved forwards by two iron bars, *m m*, pinned to the front cross bar of the carriage, *a a*; the distance between the wheel, 2, and the carriage can be varied, by altering the iron bar and pins, so as to bring the point of support, or wheel, *l*, always as near as convenient to the end of the tree. The shaft, F, may be turned by any first mover, wind, water, steam, or horses, as is most convenient, and a man regulates the wheel, I. When the borer is put in motion, by turning the wheel, I, from *o* to *p*, he draws the tree up to the borer which pierces it; when a few inches are bored, he withdraws the tree, by turning the wheel back, that the borer may throw out its chips, he then returns the tree, and continues this process until the work is finished; the borer is the shape of a common auger.

PIPE, *tobacco*, a machine used in the smoaking of tobacco, consisting of a long tube, made of earth or clay, having at one end a little case, or furnace, called the bowl, for the reception of the tobacco, the fumes whereof are drawn by the mouth through the other end. Tobacco-pipes are made of various fashions; long, short, plain, worked, white, varnished, unvarnished, and of various colours, &c. The Turks use pipes three or four feet long, made of rushes, or of wood bored, at the end thereof they fix a kind of pot of baked earth, which serves as a bowl, and which they take off after smoking.

PIPE also denotes a vessel or measure for wine, and things measured by wine-measure. It is usually reckoned two hogsheads, or 126 gallons: this is the measure found in books, but in actual life it is very different.

	Gallons.
The pipe of Port is	138
——— Madeira	110
——— Vidonia	120
——— Sherry	130
——— Lisbon, and Bucellas	140

The pipe of port is seldom accurately 138 gallons, and it is customary in trade to charge what the cask actually contains, be it more or less than the estimated quantity.

PIPE, in music, any tube formed of a reed, or of wood, metal, &c. which being inflated at one end produces a musical sound, acute or grave, soft or loud, according to the material, its form, and dimensions. The pipe, which was originally no more than a simple oaten straw, formed one of the first instruments by which melodious sounds were attempted.

PIPES *of Pan*, or *mouth organ*, a wind instrument consisting of a range of pipes bound together side by side, and gradually lessening with respect to each other in length and diameter. The longest is about six inches, and the shortest only two in length. In performing upon this instrument, it is held in the hand, and the pipes are blown into by the mouth at the upper end.

PIPE, in law, a roll in the exchequer, otherwise called the GREAT *roll*, whence there is an office called the pipe office, where they take cognizance of estreats and forfeitures to the King.

PIPER, in botany, *pepper*, a genus of the Diandria Trigynia class and order. Natural order of Piperitæ. Urticæ, Jussieu. Essential character: calyx none; corolla none; berry one-seeded. There are sixty species. Most of the peppers are perennial, with herbaceous or frutescent stems, sometimes scandent and dichotomous, the branches as it were jointed. The numerous species of this genus are natives of the East and West Indies, a few of the islands in the South Seas, and two or three of the Cape of Good Hope. P. nigrum, black pepper, grows spontaneously in the East Indies and Cochin China; it is cultivated with such success in Malacca, Java, and especially in Sumatra, that it is thence exported to every part of the world where a regular commerce has been established. White pepper was formerly thought to be a different species from the black; but it is nothing more than the ripe berries deprived of their skin, by steeping them about a fortnight in water; after which they are dried in the sun. P. betle, betel, has the

stems smooth and even, striated, angular; leaves acuminate, a little oblique at the base; peduncle longer than the petiole, and opposite to it; spike cylindrical, frequently, together with the peduncle, pendulous; petiole channeled at the base. It is the leaf of this species of pepper plant which is called betle, or betel, which serves to enclose a few slices or bits of the areca; these, together with a little chunam, or shell lime, are what the southern Asiatics universally chew to sweeten the breath and strengthen the stomach; the lower people there use it as ours do tobacco in Europe, to keep off the calls of hunger: it is there deemed the height of unpoliteness to speak to a superior without some of it in the mouth. The women of Canara on the Malabar coast, stain their teeth black with antimony, thus preserving them good to old age; the men, on the contrary, ruin theirs by the betel and chunam, or lime, which they take with it.

Piperitæ, in botany, from the word piper, pepper, the name of the second order in Linnæus's "Fragments of a Natural Method;" consisting, as the name imports, of pepper, and a few genera which agree with it in habit, structure, and sensible qualities. These plants are mostly herbaceous and perennial. The stalks of some of them creep along rocks and trees, into which they strike root at certain distances. None of them rise above fifteen feet high, and but few exceed three or four feet. The flesh roots of many of these plants, particularly those of several species of arum, are extremely acrid when fresh. They lose this pungent quality, however, by being dried, and become of a soapy nature. The pepper plant of Senegal bears a round berry, about the size of hemp seed, which, when ripe, is of a beautiful red colour, and of a sweetish taste. It contains a seed of the shape and bigness of a grain of cabbage, but very hard, and possessing an agreeable poignancy. The berries grow in small bunches on a shrub that is about four feet high, and has thin supple branches, furnished with oval leaves, that are pointed at the ends, not very unlike those of the privet.

PIPRA, the *manakin*, in natural history, a genus of birds of the order Passeres. Generic character: bill short, strong, hard, nearly triangular at the base, and slightly incurvated at the tip; nostrils naked; tail short. These birds are very similar to the genus of Titmice, and are almost all peculiar to South America. There are thirty-one species noticed, by Gmelin. Latham enumerates only twenty-five. The following are most deserving of attention. P. rupicola, or the rock manakin, is as large as a pigeon, and is a very beautiful species, inhabiting Cayenne and Guiana, and building in the holes and clefts of the rocks, in the most obscure recesses. They are very timid; but are frequently tamed, so as to accompany the domestic poultry. The female, after laying her eggs for a few years, assumes in some instances the distinctive plumage of the male, and may be mistaken for him; a circumstance, however, not peculiar to this genus of birds. The black-crowned manakin is frequent in Guiana, avoiding the open plains, and haunting the skirts of woods in small flocks. These birds are found in the neighbourhood of ant's nests, from which they are seen to spring up frequently as if stung by these insects, uttering at the moment a cry somewhat similar to the cracking of a nut.

PIRATE, one who maintains himself by pillage and robbing at sea. By statute 28 Henry VIII. c. 15, all felonies committed upon the sea, or any place where the Admiral has jurisdiction, shall be tried wherever the King shall appoint by his special commission, as if the offence had been at common law. And by statute 6 George I. if any subjects or denizens of this kingdom, commits any hostility against others of the King's subjects upon the sea, under colour of any commission from any prince or other authority, he shall be deemed a pirate, and suffer accordingly.

By statute 18 George II. c. 30, persons committing hostilities, or aiding enemies at sea, may be tried as pirates. Piracies at sea are excepted out of the general pardon by 20 George II. c. 52.

PISCES, in natural history, is the fourth class in the Linnæan system, consisting of five orders, *viz.*

Abdominales	Jugulares
Apodes	Thoracici.
Cartilaginii	

The class is described as having incumbent jaws; eggs without white; organs of sense; for covering, imbricate scales; fins for supporters: they swim in water, and smack. The several orders and other matters relative to fishes have been treated of in the article Ichthyology, and in the several parts of the Dictionary, in the alphabetical order of the genera, &c. To this article we have referred, intending to give under it a brief account of the functions of the several

fishes. Of these the most important is respiration, which is performed by means of gills, which supply the place of lungs. Air is equally necessary to the existence of fish as it is to other animals. In general, a fish first receives a quantity of water by the mouth, from which it is driven to the gills; these close, and prevent the water from returning by the mouth, at the same time that their bony covering prevents it from passing through them, until the proper quantity of air has been extracted from it. The covers then open, and give it a free passage; by which means the gills are again opened, and admit a fresh body of water. This process, in fishes, as breathing in the human subject, is carried on during sleep, and is repeated about twenty-five times in a minute; and the necessity of it is evinced from the circumstance of fish being certainly killed in water, from which air is taken away by means of the air-pump, or excluded by very severe frost. Should the free play of the gills be even suspended, or their covers kept from moving, by a string tied round them, the fish would fall into convulsions, and die in a few minutes. It is said, likewise, that though the branchial apparatus be comprized in a small compass, its surface when fully extended would occupy many square feet; a fact, that may convince the most sceptical, of the numberless convolutions and ramifications in which the included water is elaborated and attenuated, in the course of giving out its air in the respiratory process.

Fishes have the organs of sense, some of them probably in a very high degree, and others imperfectly; of the latter kind are the senses of touch and of taste: but the sense of hearing has now been completely ascertained, which was long doubted, and by some physiologists denied: the organ is contained in the cavity of the head; it was discovered by Professor Camper, who remarks, that "fish perceive sound, but sound peculiar to the watery element." This organ has been observed and described by Mr. Hunter, in the Philosophical Transactions, who has likewise ascertained that its structure varies in different species. And Dr. Shaw, in his "Introduction to the Natural History of Fishes," Vol. IV. Part I. observes, that "Fishes, particularly of the skate kind, have a bag at some distance behind the eyes, which contains a fluid, and a soft cretaceous substance, and supplies the place of the vestibule and cochlea: there is a nerve distributed upon it similar to the portio mollis in man: they have semicircular canals, which are filled with a fluid, and communicate with the bag; they have likewise a meatus externus, which leads to the internal ear. The cod-fish, and others of the same shape, have an organ of hearing somewhat similar to the former, but instead of a soft substance contained in the bag, there is a hard cretaceous stone." From the same work we shall transcribe the observations on the sense of smelling and that of sight.

"The organ of smelling is large, and the animals have a power of contracting and dilating the entry to it as they have occasion. It seems to be mostly by their acute smell that they discover their food, for their tongue seems not to have been designed for a very nice sensation, being of a pretty firm cartilaginous substance; and common experience evinces that their sight is not of so much use to them as their smell in searching for their nourishment. If you throw a fresh worm into the water, a fish shall distinguish it at a considerable distance; and that this is not done by the eye, is plain from observing, that after the same worm has been a considerable time in the water, and lost its smell, no fishes will come near it; but if you take out the bait, and make several little incisions into it, so as to let out more of the odoriferous effluvia, it shall have the same effect as formerly. Now it is certain, that had the animals discovered this bait with their eyes, they would have come equally to it in both cases. In consequence of their smell being the principal means they have of discovering their food, we may frequently observe them allowing themselves to be carried down with the stream, that they may ascend again leisurely against the current of the water: thus the odoriferous particles swimming in that medium, being applied more forcibly to their organs of smell, produce a stronger sensation.

"The optic nerves in fishes are not confounded with one another in their middle progress between their origin and the orbit, but the one passes over the other without any communication; so that the nerve which comes from the left side of the brain goes distinctly to the right eye, and *vice versa*. Indeed it should seem not to be necessary for the optic nerves of fishes to have the same kind of connection with each other as those of man have; for their eyes are not placed in the fore-part, but in the sides of the head; and, consequently, cannot look

so conveniently at any object with both eyes at the same time. The crystalline lens in fishes is a complete sphere, and more dense than in terrestrial animals, that the rays of light coming from the water might be sufficiently refracted. As fishes are continually exposed to injuries in the uncertain element in which they reside, and as they are in perpetual danger of becoming a prey to the larger ones, it was necessary that their eyes should never be shut; and as the cornea is sufficiently washed by the element they live in, they are not provided with palpebræ; but, as in the current itself the eye must be exposed to several injuries, there was a necessity that it should be sufficiently defended; which, in effect, it is, by a firm pellucid membrane, seeming to be a continuation of the cuticula stretched over it: the epidermis is very proper for this purpose, as being insensible, and destitute of vessels, and consequently not liable to obstructions, and thus becoming opaque. In the eye of the skate tribe there is a digitated curtain which hangs over the pupil, and which may shut out the light when the animal rests, being somewhat similar to the tunica adnata of other animals."

We now proceed to notice the motion of fishes, for the celerity of which their shape is admirably adapted: hence, vessels designed to be navigated in water are made to imitate, in some degree or other, the shape of fish; but the rapidity of a ship in sailing before the wind is not to be compared to the velocity of a fish. The largest fishes are known to overtake a ship in full sail with the greatest ease, to play round it without effort, and to surpass it at pleasure. Every part of the body seems formed for dispatch: the fins, the tail, and the motion of the whole back-bone assist in the business; and it is to that flexibility of body which mocks the efforts of art, that fishes owe the great velocity of their motions. The chief instruments in a fish's motion are its fins, air-bladder, and tail; with two pair, and three single fins, it will migrate a thousand leagues in a season, and without indicating any visible symptoms of languor or fatigue. The fins serve not only to assist the animal in progression, but in rising and sinking, in turning, and even in leaping out of the water. The pectoral fins serve to push the animal forward, and to balance the head when it is too large for the body, and prevent it from tumbling to the bottom, which it infallibly would if the fins were cut off. The ventral fins, which always lie flat in the water, serve rather to raise or depress the body, than to assist its progressive motion. The dorsal fin acts as a poiser, in preserving the animal's equilibrium, while it aids the forward movement; and the anal fin is designed to maintain the vertical position of the body. By means of the air bladder, fishes can increase or diminish the specific gravity of their body. When they contract it, and press out the air, the bulk of the body is diminished, and the fish sinks as far as it pleases: on relaxing the operation, the bladder acquires its natural size, the body becomes specifically lighter, and the fish is enabled to swim near the surface. The tail, in the last place, may be regarded as the rudder, directing the motions of the fish, to which the fins are only subservient.

With respect to the nourishment of fishes: they are mostly carnivorous, though they seize upon almost any thing that falls in their way, and not uncommonly devour their own offspring: they seem, indeed, to manifest a particular predilection for whatever they can swallow possessed of life. They often meet with each other in fierce opposition, and the victor, without scruple, devours his antagonist. Thus are they irritated by the continual desire of satisfying their hunger; and the life of a fish, from the smallest to the greatest, is but one scene of hostility and violence. The smaller species, which stand no chance in the unequal combat, resort to those shallows where the larger are unable to approach. There they become invaders in their turn, and live on the spawn of large fishes, which they find floating on the water, till at length they are imprisoned, and leisurely devoured by the mussel, oyster, &c. which lie in ambush at the bottom. Fishes can, however, notwithstanding their natural voracity, live long, apparently, without food; but they, perhaps, in vases and other ornamental vessels, feed on insects too small for the human eye to see; or, it has been thought, they may have the power of chemically decomposing water. We now proceed to the subject of reproduction.

In most, if not in all fishes, there is a difference in sex, though Bloch and others make mention of individuals, which seemed to unite the two sexes, and to be real hermaphrodites. The number of males, it has been remarked, is about double that of females; and were it not for this wise provision of nature, a large proportion of the extruded eggs would remain unfecundated.

A few species, indeed, as the eel, blenny, &c. are viviparous; but by far the greater number are produced from eggs. These last compose the roe, ovaries of the females, which lie along the abdomen. The milt of the males is disposed along the back-bone, in one or two bags, and consists of a whitish glandular substance, which secretes the spermatic fluid. Though the history of the generation of fishes be still involved in considerable obscurity, it seems to be ascertained, that no sexual union takes place among the oviparous kinds, and that the eggs are fructified after exclusion. They are of a spherical form, and consist of a yolk, a white part, and a bright crescent-like spot, or germ. The yolk, which is usually surrounded by the white, is round, and not placed in the middle, but towards one of the sides; and the clear spot, or embryo, is situated between the yolk and the white.

In this spot there is observable, on the day after fecundation, a moveable point, of a somewhat dull appearance. On the third day, it assumes the appearance of a thickish mass, detached on one side, and on the other strongly adhering to the yolk, and presenting the contour of the heart, which at this period receives an increase of motion, while the disengaged extremity, which forms the rudiments of the tail, is perceived to move at intervals. On the fourth day, the pulsations of the heart, and the movements of the whole body occur in quicker succession. On the fifth, the circulation of the humours in the vessels may be discerned, when the fish is in a particular position. On the sixth, the back-bone may be distinctly recognised. On the seventh, two black points, which are the eyes, and the whole form of the animal, are visible to the naked eye. Although the yolk gradually diminishes as the embryo enlarges, the included animal cannot yet stretch itself at length, but makes a curve with its tail. Its motions are then so brisk, that when it turns its body, the yolk turns with it; and these motions become more and more frequent, as the moment of birth, which happens between the seventh and ninth day, approaches. By repeated strokes of the tail, the covering of the egg at length gives way, and the fish comes forth, first by the tail, redoubling its efforts, till it detach its head; and then it moves nimbly, and at liberty, in its new element.

Fishes have different seasons for depositing their spawn. Some, which live in the depths of the ocean, are said to choose the winter months; but, in general, those with which we are acquainted choose the hottest months in summer, and prefer such water as is somewhat tepified by the beams of the sun. They then leave the deepest parts of the ocean, which are the coldest, and shoal round the coasts, or swim up the fresh-water rivers, which are warm as they are comparatively shallow, depositing their eggs where the sun's influence can most easily reach them, and seeming to take no farther charge of their future progeny. Of the eggs thus deposited scarcely one in a hundred brings forth an animal, as they are devoured by all the lesser fry which frequent the shores, by aquatic birds near the margin, and by the larger fish in deep water. Still, however, the sea is amply supplied with inhabitants: and notwithstanding their own rapacity, and that of various tribes of fowls, the numbers that escape are sufficient to relieve the wants of a considerable portion of mankind. Indeed, when we consider the fecundity of a single fish, the amount will seem astonishing. If we should be told, for example, that a single being could in one season, produce as many of its kind as there are inhabitants in England, it would strike us with surprise: yet the cod annually spawns, according to Lewenhoeck, above nine million of eggs contained in a single roe. The flounder is commonly known to produce above one million; and the mackarel above five hundred thousand; a herring of a moderate size will yield at least ten thousand; a carp, of fourteen inches in length, contained, according to Petit, two hundred and sixty-two thousand two hundred and twenty-four; and another, sixteen inches long, contained three hundred and forty-two thousand one hundred and forty-four; a perch deposited three hundred and eighty thousand six hundred and forty; and a female sturgeon, seven million six hundred and fifty-three thousand two hundred. The viviparous species are by no means so fruitful; yet the blenny brings forth two or three hundred at a time, all alive and playing round the parent together.

Pisces, in astronomy, the twelfth sign or constellation of the zodiac. The stars in Pisces, in Ptolemy's catalogue, are thirty-eight; in Tycho's thirty-three; and in the Britannic catalogue one hundred and nine.

PISCIDA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Legumi-

nosæ. Essential character: stigma acute; legume winged four ways. There are two species, *viz.* P. erythrina, Jamaica dogwood tree, and P. carthaginensis, both natives of the West Indies.

PISCIS *australis*, the southern fish, is a constellation in the southern hemisphere, being one of the forty-eight constellations mentioned by the ancients. The star tomahaut, of the first magnitude, is in the mouth of this fish. Piscis volans, the flying fish, is a small constellation of the southern hemisphere, added by the moderns: it contains eight stars, but is not visible in our latitude.

PISONIA, in botany, so named in honour of William Piso, a physician, a genus of the Polygamia Dioecia class and order. Natural order of Nyctagines, Jussieu. Essential character: calyx scarcely any; corolla bell-shaped, five-cleft; stamina five or six; pistil one; capsule superior, one-celled, valveless: male and female on the same or on different plants. There are five species.

PISTACIA, in botany, a genus of the Dioecia Pentandria class and order. Natural order of Amentaceæ. Terebintaceæ, Jussieu. Essential character: male an ament; calyx five-cleft; corolla none: female distinct; calyx trifid; corolla none; styles two; drupe one-seeded. There are six species, among which we shall notice the P. lentiscus, mastick tree; it is about eighteen or twenty feet in height, the trunk is covered with a greyish bark, the branches are numerous, the leaves have three or four pairs of small leaflets, of a lucid green on their upper, but pale on their under side; the male flowers come out in loose clusters from the sides of the branches, of an herbaceous colour, appearing in May, and soon falling off; they are generally on different plants from the fruits, which also grow in clusters, and are small berries of a black colour when ripe.

PISTAZITE, in mineralogy, is of pistachio green, passing sometimes into olive green, and blackish green. It occurs massive and crystallized. Internally it is shining; fracture sometimes foliated, sometimes narrow, parallel and stellular, diverging radiated. It is hard, easily frangible, and not very heavy. It occurs in beds in primitive mountains in Norway, Germany, and France.

PISTIA, in botany, a genus of the Monadelphia Octandria class and order. Natural order of Miscellaneæ. Hydrocharides, Jussieu. Essential character: calyx none; corolla one-petalled, tongue-shaped, entire; anthers six or eight, placed on the filament; style one; capsule one-celled at the bottom of the corolla. There is but one species, *viz.* P. stratiotes, a native of Asia, Africa, and South America, in stagnant waters.

PISTILLA, in botany. See BOTANY.

PISTOLE, a gold coin struck in Spain, and in several parts of Italy, Switzerland, &c. equal to about ten shillings and sixpence of our money.

PISTON, in pump-work, is a short cylinder of metal, or other solid substance, fitted exactly to the cavity of the barrel or body of the pump. There are two kinds of pistons used in pumps, the one with a valve, and the other without a valve, called a forcer.

PISUM, in botany, *pea*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: style triangular, above keeled, pubescent; calyx has the two upper segments shorter. There are three species, of which we shall mention P. sativum, the common pea. Many varieties of this are cultivated in England; the Hotspurs and Hastings have their names from their coming to bear early in the season; new varieties of these are raised almost every year, which, because they differ in some slight particular, are sold at an advanced price, having frequently the names of the persons who raised them, or the place where they first grew. These varieties are not permanent, and, without the greatest care, will soon degenerate.

PITCAIRNIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Bromeliæ, Jussieu. Essential character: calyx three-leaved or three-parted, half superior; corolla three-petalled, with a scale at the base of each petal; stigmas three, contorted; capsule three, opening inwards; seeds winged. There are three species, natives of the West Indies.

PITCH, a tenacious oily substance, drawn chiefly from pines and firs, and used in shipping, medicine, and various other arts: or it is more properly tar, inspissated by boiling it over a slow fire. The method of procuring the tar, is by cleaving the trees into small billets, which are laid in a furnace that has two apertures, through one of which the fire is put, and through the other the pitch is gathered, which, oozing from the wood, runs along the bottom of the furnace into places made to receive it.

When the smoke, which is here very thick, gives it its blackness; this is called tar, which, on being boiled, to consume more of its moisture, becomes pitch. There is another method of drawing pitch, used in the Levant: a pit is dug in the ground, two ells in diameter at the top, but contracting as it grows deeper; this is filled with branches of pine, cloven into shivers; the wood at the top of the pit is then set on fire, and burning downwards, the tar runs from it, out of a hole made in the bottom; and this is boiled, as above, to give it the consistence of pitch. See TURPENTINE.

PITCH, in music, the acuteness or gravity of any particular sound, or of the tuning of any instrument. A sound less acute than some other sound with which it is compared, is said to be of a lower pitch than that other sound; and *vice versa*.

PITCHING, in naval affairs, is the vertical vibration which the length of a ship makes about her centre of gravity, or the motion by which she plunges her head and after part alternately into the hollow of the sea. This motion may proceed from the waves that agitate the vessel, or the wind acting upon the sails, which makes her stoop at every blast.

PITCH *pipe*, in music, an instrument used by vocal practitioners to ascertain the pitch of the key in which they are about to sing. It is blown at one end, like a common flute, and being shortened or lengthened by a scale, is capable of producing, with great exactness, all the semitones within its compass.

PITCH *stone*, in mineralogy, is of various colours, as grey, green, yellow, and red, in their several shades, but generally of the paler cast. It occurs in mass. Internally it is shining, with a greasy lustre. Its fracture is conchoidal, passing into splintery, it approaches to hornstone. Its fragments are angular and sharp-edged. Sometimes it occurs in smooth granular distinct concretions. It is hard, brittle, and easily frangible, and the specific gravity is 2.3. It is fusible, by means of the blow-pipe, into a porous enamel. It is composed of

Silica	64.58
Alumina	15.41
Oxide of Iron	5
	84.99
Loss	15.01
	100

This mineral occurs in mountain masses, and constitutes entire mountains. It forms the base of a particular kind of porphyry, and abounds in many parts of Germany and Siberia.

PITTOSPORUM, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx deciduous; petals five, converging into a tube; capsule two to five valved, two to five celled; seeds covered with a pulp. There are three species.

PIVOT, a foot or shoe of iron, or other metal, usually conical, or terminating in a point, whereby a body, intended to turn round, bears on another fixed at rest, and performs its circumvolutions. The pivot usually bears or turns round in a sole, or piece of iron or brass, hollowed to receive it.

PLACARD, or PLACART, among foreigners, signifies a leaf or sheet of paper, stretched out, and applied on a wall or post, containing edicts, regulations, &c.

PLACE, in law, where a fact was committed, is to be alledged in appeals of death, indictments, &c.

PLACE, in philosophy, a mode of space, or that part of immoveable space which any body possesses. Place is to space or expansion, says Mr. Locke, as time is to duration. Our idea of place is nothing but the relative position of any thing with reference to its distance from some fixed and certain points. Whence we say, that a thing has or has not changed place, when its distance either is or is not altered with respect to those bodies with which we have occasion to compare it. That this is so, continues that great philosopher, we may easily gather from hence, that we have no idea of the place of the universe, though we can of all its parts. To say that the world is somewhere, means no more than that it does exist: however, the word place is sometimes taken to signify that space which any body takes up; and in this sense, according to the same author, the universe may be conceived in a place: but he thinks that this portion of infinite space possessed by the material world, might more properly be called extension.

PLACE, in war, a general name for all kinds of fortresses where a party may defend themselves: thus, 1. A strong or fortified place, is one flanked, and covered with bastions. 2. A regular place, one whose angles, sides, bastions, and other parts, are equal; and this is usually denominated

from the number of its angles, as a pentagon, hexagon, &c. 3. Irregular place, is one whose sides and angles are unequal. 4. Place of arms, is a strong city or town pitched upon for the chief magazine of an army; or, in a city or garrison, it is a large open spot of ground, usually near the centre of the place where the grand guard is commonly kept, and the garrison holds its rendezvous at reviews; and in cases of alarm to receive orders from the governor. 5. Place of arms of an attack, in a siege, is a spacious place covered from the enemy by a parapet or epaulement, where the soldiers are posted ready to sustain those at work in the trenches against the soldiers of the garrison. 6. Place of arms particular, in a garrison, a place near every bastion where the soldiers sent from the grand place to the quarters assigned them, relieve those that are either upon the guard or in sight. 7. Place of arms without, is a place allowed to the covert way for the planting of cannon, to oblige those who advance in their approaches to retire. 8. Place of arms in a camp, a large place at the head of the camp for the army to be ranged in and drawn up in battalia. There is also a place for each particular body, troop, or company, to assemble in.

PLACENTA. See MIDWIFERY.

PLAGIANTHUS, in botany, a genus of the Monadelphia Dodecandria class and order. Essential character: calyx five-cleft; petals five, two approximating, remote from the other three; berry. There is but one species, viz. P. divaricatus, a native of New Zealand.

PLAGIARY, in philology, the purloining another person's works, and putting them off for a man's own.

PLAGUE. Any infectious distemper in foreign countries may be declared the plague, by the King's proclamation. And there are several very salutary regulations by our statute law for the performance of quarantine in order to prevent the extending of infection.

PLAIN *table*, in surveying, a very simple instrument, whereby the draught of a field is taken on the spot, without any future protraction. It is generally of an oblong rectangular figure, and supported by a fulcrum, so as to turn every way by means of a ball and socket. It has a moveable frame, which serves to hold fast a clean paper; and the sides of this frame, facing the paper, are divided into equal parts every way. It has also a box with a magnetical needle, and a large index with two sights; and, lastly, on the edge of the frame, are marked degrees and minutes. See SURVEYING.

PLAIN *number*, is a number that may be produced by the multiplication of two numbers into one another: thus 20 is a plain number produced by the multiplication of 5 and 4.

PLAIN *problem*, in mathematics, is such a problem as cannot be solved geometrically, but by the intersection either of a right line and a circle, or of the circumferences of two circles; as, given the greatest side, and the sum of the other two sides of a right-angled triangle, to find the triangle, as also to describe a trapezium that shall make a given area of four given lines. Such problems can only have two solutions, because a right line can only cut a circle, or one circle cut another in two points.

PLAIN, in heraldry, sometimes denotes the point of the shield, when couped square; a part remaining under the square, of a different colour or metal from the shield. This has been sometimes used as a mark of bastardy, and called champaigne; for, when the legitimate descendants of bastards have taken away the bar, fillet, or traverse borne by their fathers, they are to cut the point of the shield with a different colour called plain.

PLAISE. See PLEURONECTES.

PLAN, in general denotes the representation of something drawn on a plane: such are maps, charts, ichnographies, &c. See MAP, CHART, &c.

The term plan, however, is particularly used for a draught of a building, such as it appears, or is intended to appear, on the ground; shewing the extent, division, and distribution of its area, or ground-plot, into apartments, rooms, passages, &c. A geometrical plan is that, wherein the solid and vacant parts are represented in their natural proportions. The raised plan of a building, is the same with what is otherwise called an elevation, or orthography. A perspective plan, is that exhibited by degradations, or diminutions, according to the rules of perspective.

PLANARIA, in natural history, a genus of the Vermes Intestina class and order. Generic character: body gelatinous, flattish, with a double ventral pore; mouth terminal. There are about fifty species divided into six sections, distinguished by the number of their eyes: A without eyes; B

with a single eye: C with two eyes: D with three eyes: E with four eyes: and F with numerous eyes. Of the first division we may notice, P. quadrangularis; body pale, ovate, very sharp-pointed before, and winged with small curled longitudinal membranes. It is found in ditches among duck-weed; very soft, pellucid, of a changeable form, and moves like a slug, leaving a slime on the bodies it passes over; when it meets another animal it draws itself in like a snail.

PLANE, in geometry, denotes a plain surface, or one that lies evenly between its bounding lines: and as a right line is the shortest extension from one point to another, so a plain surface is the shortest extension from one line to another. In astronomy, conics, &c. the term plane, is frequently used for an imaginary surface, supposed to cut and pass through solid bodies; and on this foundation, is the whole doctrine of conic sections built. See Conic *sections*.

In perspective, we meet with the perspective plane, which is supposed to be pellucid, and perpendicular to the horizon; the horizontal plane, supposed to pass through the spectator's eye, parallel to the horizon; the geometrical plane, likewise parallel to the horizon, whereon the object to be represented is supposed to be placed, &c. See Perspective.

The plane of projection, in the stereographic projection of the sphere, is that on which the projection is made; corresponding to the perspective plane.

Plane, in joinery, an edged tool, or instrument for paring and shaving of wood smooth. It consists of a piece of wood, very smooth at bottom, as a stock or shaft; in the middle of which is an aperture, through which a steel-edge, or chissel, placed obliquely, passes, this being very sharp, takes off the inequalities of the wood it is slid along. Planes have various names, according to their various forms, sizes, and uses: as, 1. The fore-plane, which is a very long one, and is usually that which is first used: the edge of its iron or chissel is not ground straight, but rises with a convex arch in the middle; its use is to take off the greater irregularities of the stuff, and to prepare it for the smoothing-plane. 2. The smoothing-plane is short and small, its chissel being finer: its use is to take off the greater irregularities left by the fore-plane, and to prepare the wood for the jointer. 3. The jointer is the longest of all; its edge is very fine, and does not stand out above an hair's breadth; it is chiefly used for shooting the edge of a board perfectly straight, for jointing tables, &c. 4. The strike-block, which is like the jointer, but shorter: its use is to shoot short joints. 5. The rabbit-plane, which is used in cutting the upper edge of a board, straight or square, down into the stuff, so that the edge of another cut after the same manner, may join in with it, on the square; it is also used in striking facias on mouldings; the iron or chissel of this plane is as broad as its stock, that the angle may cut straight, and it delivers its shavings at the sides, and not at the top, like the others. 6. The plough, which is a narrow-rabbit plane, with the addition of two staves, on which are shoulders: its use is to plough a narrow square groove on the edge of a board. 7. Moulding-plane, which are of various kinds, accommodated to the various forms and profiles of the moulding; as the round-plane, the hollow-plane, the ogee, the snipe's bill, &c. which are all of several sizes from half an inch, to an inch and a half.

PLANE *tree*. See Platanus.

PLANET, a celestial body, revolving round the Sun as a centre, and continually changing its position, with respect to the fixed stars; whence the name planet, which is a Greek word signifying wanderer.

The planets are usually distinguished into primary and secondary. The primary ones, called, by way of eminence, planets, are those which revolve round the Sun as a centre; and the secondary planets, more usually called satellites, or moons, are those which revolve round a primary planet as a centre, and constantly attend it in its revolution round the Sun. See Astronomy.

The primary planets are again distinguished into superior and inferior. The superior planets are those further from the Sun than our Earth; as Mars, Jupiter, Saturn, and the Herschel: and the inferior planets are those nearer the Sun than our Earth; as Venus and Mercury; for the astronomy, and other peculiarities, of which, see Jupiter, Mars, &c.

Planets, *nature of the*. That the planets are opaque bodies, like our Earth, appears evident for the following reasons: 1. Since in Venus, Mercury, and Mars, only that part of the disc illuminated by the Sun, is found to shine; and, again, Venus and Mercury, when between the Earth and the Sun, appear like dark spots, or maculæ, on the Sun's disc; it is evident that Mars, Venus,

and Mercury, are opaque bodies, illuminated with the borrowed light of the Sun. And the same appears of Jupiter, from its being void of light in that part to which the shadow of the satellites reaches, as well as in that part turned from the Sun; and that his satellites are opaque, and reflect the Sun's light, is abundantly shown. Wherefore, since Saturn, with his ring and satellites, only yield a faint light, fainter considerably than that of the fixed stars, though these be vastly more remote, and than that of the rest of the planets: it is past doubt, he too, with his attendants, are opaque bodies. 2. Since the Sun's light is not transmitted through Mercury and Venus, when placed against him, it is plain they are dense opaque bodies; which is likewise evident of Jupiter, from his hiding the satellites in his shadow; and therefore, by analogy, the same may be concluded by Saturn. 3. From the variable spots in Venus, Mars, and Jupiter, it is evident these planets have a changeable atmosphere; which changeable atmosphere may, by a like argument, be inferred of the satellites of Jupiter, and therefore by similitude the same may be concluded of the other planets. 4. In like manner, from the mountains observed in Venus, the same may be supposed in the other planets. 5. Since then, Saturn, Jupiter, both their satellites, Mars, Venus, and Mercury, are opaque bodies, shining with the Sun's borrowed light, are furnished with mountains, and encompassed with a changeable atmosphere; they have, of consequence, waters, seas, &c. as well as dry land, and are bodies like the Moon, and therefore like the Earth, And hence, it seems highly probable that the other planets have their animal inhabitants, as well as our Earth.

Planets, *masses of*. It would appear, at first view, impossible to ascertain the respective masses of the Sun and planets, and to calculate the velocity with which heavy bodies fall towards each when at a given distance from their centres; yet these points may be determined from the theory of gravitation without much difficulty. It follows, however, from certain theorems relative to centrifugal forces, that the gravitation of a satellite towards its planet is to the gravitation of the Earth towards the Sun, as the mean distance of the satellite from its primary, divided by the square of the time of its sidereal revolution, or the mean distance of the Earth from the Sun divided by the square of a sidereal year. To bring these gravitations to the same distance from the bodies which produce them, we must multiply them respectively by the squares of the radii of the orbits which are described: and, as at equal distances the masses are proportional to the attractions, the mass of the Earth is to that of the Sun as the cube of the mean radius of the orbit of the satellite, divided by the square of the time of its sidereal motion, is to the cube of the mean distance of the Earth from the Sun, divided by the square of the sidereal year. Let us apply this result to Jupiter. The mean distance of his fourth satellite subtends an angle of 1530″.86 decimal seconds. Seen at the mean distance of the Earth from the Sun, it would appear under an angle of 7964″.75 decimal seconds. The radius of the circle contains 636,619″.8 decimal seconds. Therefore the mean radii of the orbit of Jupiter's fourth satellite, and of the Earth's orbit are to each other as these two numbers. The time of the sidereal revolution of the fourth satellite is 16.6890 days; the sidereal year is 365.2564 days. These data give us $\frac{1}{1066.08}$ for the mass of Jupiter, that of the Sun being represented by I. It is necessary to add unity to the denomination of this fraction, because the force which retains Jupiter in his orbit is the sum of the attractions of Jupiter and the Sun. The mass of Jupiter is then $\frac{1}{1067.08}$. The mass of Saturn and Herschel may be calculated in the same manner. That of the Earth is best determined by the following method: If we take the mean distance of the Earth from the Sun for unity, the arch described by the Earth in a second of time will be the ratio of the circumference to the radius divided by the number of seconds in a sidereal year. If we divide the square of that arch by the diameter, we obtain $\frac{1479565}{10^{20}}$ for its versed sine, which is the deflection of the Earth towards the Sun in a second. But on that parallel of the Earth's surface, the square of the sine of whose latitude is $\frac{1}{3}$, a body falls in a second $16\frac{1}{4}$ feet. To reduce this attraction to the mean distance of the Earth from the Sun, we must divide the number by the feet contained in that distance; but the radius of the Earth at the above-mentioned parallel is 19,614,648 French feet. If we divide this number by the tangent of the solar parallax, we obtain the mean radius of the Earth's orbit expressed in feet. The

effect of the attraction of the Earth at a distance equal to the mean radius of its orbit, is equal to $\frac{16\frac{1}{4}'}{19614648}$ multiplied by the cube of the tangent of the solar parallax $= \frac{1479560.5}{10^{20}}$. Hence the masses of the Sun and Earth are to each other as the numbers 1479560.5 and 4.486113; therefore the mass of the Earth is $\frac{1}{329809}$, that of the Sun being unity. M. de la Place calculated the masses of Mars and Venus from the secular diminution of the obliquity of the ecliptic, and from the mean acceleration of the Moon's motion. The mass of Mercury he obtained from its volume, supposing the densities of that planet and of the Earth reciprocally as their mean distance from the Sun, a rule which holds with respect to the Earth, Jupiter, and Saturn. The following table exhibits the masses of the different planets, that of the Sun being unity:

Mercury..................	$\frac{1}{2025810}$
Venus....................	$\frac{1}{383137}$
Earth....................	$\frac{1}{329809}$
Mars.....................	$\frac{1}{1846082}$
Jupiter..................	$\frac{1}{1067.09}$
Saturn...................	$\frac{1}{3359.40}$
Herschel.................	$\frac{1}{19504}$

The densities of bodies are proportional to their masses divided by their bulks; and when bodies are nearly spherical, their bulks are as the cubes of their semi-diameters, of course the densities in that case are as the masses divided by the cubes of the semi-diameters.

PLANETS, *motion of the.* Each of the primary planets bend their course about the centre of the Sun, and are accelerated in their motions as they approach to him, and retarded as they recede from him; so that a ray, drawn from any one of them to the Sun, always describes equal spaces, or areas, in equal times: whence it follows that the power which bends their way into a curve line, must be directed to the Sun. This power is no other than that of gravitation, which we have already proved to increase, as the square of the planet's distance from the Sun decreases. See GRAVITATION, &c. But the universality of this law still further appears, by comparing the motions of the different planets: for the power which acts on a planet near the Sun, is manifestly greater than that which acts on a planet more remote; both because it moves with greater velocity, and because it moves in a lesser orbit, which has more curvature, and separates further from its tangent, in arcs of the same length, than in a greater orbit. By comparing the motion of the planets, the velocity of a nearer planet is found to be greater than that of one more remote, in the proportion of the square-root of the number which expresses the greater distance, to the square root of that which expresses the lesser distance; so that if one planet was four times further from the Sun than another, the velocity of the first would be half the velocity of the latter; and the nearer planet would describe an arc in one minute, equal to the arc described by the other planet in two minutes: and though the curvature of the orbits were the same, the nearer planet would describe, by its gravity, four times as much space as the other would describe in the same time; so that the gravity of the nearer planet would appear to be quadruple, from the consideration of its greater velocity only. But besides this, as the radius of the lesser orbit is supposed to be four times less than the radius of the other, the lesser orbit must be four times more curved; and the extremity of a small arc of the same length, will be four times further below the tangent, drawn at the other extremity, in the lesser orbit than in the greater; so that, though the velocities were equal, the gravity of the nearer planet would, on this account only, be found to be quadruple. Hence, on both these accounts together, the greater velocity of the nearer planet, and the greater curvature of its orbit, its gravity towards the Sun must be supposed sixteen times greater, though its distance from the Sun is only four times less than that of the other; that is, when the distances are as 1 to 4, the gravities are reciprocally as the squares of these numbers, or as 16 to 1. And in the same manner as this principle governs the motions of the primary planets of the great solar system, acts at their surfaces, and keeps their parts together; so it governs also the motions of the satellites, or secondary planets, in the lesser systems of which the greater is composed, and is extended around them, decreasing in the same manner as the squares of the distances increase. The comets are

evidently governed by the same law, since they descend with an accelerated motion, as they approach towards the Sun, and ascend again with a retarded motion, bending their way about the Sun, and describing equal areas in equal times, by rays drawn from them to his centre. See Astronomy.

PLANETARIUM, an astronomical machine, contrived to represent the motions, orbits, &c. of the planets, as they really are in nature, or according to the Copernican system. A very remarkable machine of this sort was invented by Huygens, which is still preserved among the curiosities of the University at Leyden. In this planetarium, the five primary planets perform their revolutions about the Sun, and the Moon performs her revolution about the Earth, in the same time that they are really performed in the heavens. Also the orbits of the Moon and planets are represented with their true proportions, excentricity, position, and declination from the ecliptic or orbit of the Earth. So that, by this machine, the situation of the planets, with the conjunctions, oppositions, &c. may be known, not only for the present time, but for any other time, either past or yet to come, as in a perpetual ephemeris. There was exhibited in London, *viz.* in the year 1791, a still much more complete planetarium of this sort, called "a planetarium, or astronomical machine, which exhibits the most remarkable phenomena, motions, and revolutions of the universe; invented, and partly executed, by the celebrated M. Hahn, member of the academy of sciences at Erfurt; but finished and completed by M. A. de Mylius." This is a most stupendous and elaborate machine, consisting of the solar system in general, with all the orbits and planets in their due proportions and positions; as also the several particular planetary systems of such as have satellites, as of the Earth, Jupiter, &c.; the whole kept in continual motion by a chronometer, or grand eight-day clock; by which all these systems are made perpetually to perform all their motions exactly as in nature, exhibiting at all times the true and real motions, positions, aspects, phenomena, &c. of all the celestial bodies, even to the very diurnal rotation of the planets, and the unequal motions in their elliptic orbits. A description was published of this most superb machine; and it was purchased and sent as one of the presents to the Emperor of China, in the embassy of Lord Macartney.

We shall now give a description of one of these machines in common use.

Fig. 1, Plate Planetarium, is an elevation of the mechanism of a planetarium; and fig. 2, a plan of the same. A, (fig. 1,) is a ball of brass representing the sun, supported by a wire screwed to a bridge, *b*, fixed beneath the board, B B, which supports the whole instrument; *a* is the section of an endless screw, which has a small handle on the end of its spindle to turn it by; it gives motion to a worm-wheel, 60, of sixty teeth, the arbor of this wheel is a tube, and goes over the central wire sustaining the Sun, to its upper end is fixed the frame, E E, containing the wheel-work, and carrying the Earth, ⊕, and Moon, ☾. The plan, (fig. 2) is this frame of wheels, the upper plate of the frame being removed, *d* is the first wheel of sixty-four teeth, fixed fast to the central wire of the sun, and having no motion, it works with another of sixty-four, on the same arbor, *h h*, with several others to be hereafter described; it turns another, *f*, of sixty-four, on whose arbor, *g*, the Earth is fixed; as *d* is fixed, and the next wheel, with its frame, E E, rolls round it, and is thereby turned upon its own axis; the wheel, *f*, which is on the other side, will have no motion on its axis, and the axis of the Earth, fixed to it, will remain parallel to itself, while it describes an orbit round the Sun, by the motion of the frame, E E. The next wheel, 60, upon the arbor, *h*, turns a pinion, 14, of fourteen teeth, (not seen in the plan) by the intervention of a wheel, 64, which does not alter its velocity; the arbor of the pinion is a tube, and fitted upon the central wire; at its upper end it supports the planet, Mercury, ☿. The third wheel from the bottom, on the arbor, *h*, has forty teeth, and by the wheel, 56, communicates motion to a small wheel of twenty-four, which has the planet, Venus, ♀, fixed to its tubular arbor. The upper wheel of the arbor, *h*, has seventy-four teeth, and turns a pinion of six, on a tube concentric with *g*, and with it the Moon. There is a small wheel of fourteen teeth between the wheel and pinion, but it does not alter the velocity: *k*, (fig. 1), is a thin brass ring seen edgeways, which has a wire diametrically across it on which it turns as an axis, to set it at any given obliquity to the axis, *g*, supporting the Earth, the wire is fixed into a short tube, which turns stiffly in a hole made in the upper plate of the frame, E E, and thus the circle can be turned round, while its plane continues oblique to the

axis, g, this ring represents the plane of the Moon's orbit, and is engraved with the different phases of the Moon. The Moon is not fixed to the arm which turns it, but its stem slides up and down in a short tube fixed to the arm, and rests upon the ring, so as to describe a parallel plane to it. On the end of the frame, E E, a pillar is erected to support a small semi-circular piece of brass, m, inclosing the Earth, and showing the line of light and darkness. N is a tube screwed fast to the board, B B, by a flanch at the lower end; it fits the outside of the tube of the wheel, 60, beneath the board, and thus steadies the whole frame as it turns round; upon this tube long arms are fitted, carrying Mars, Jupiter, and the other superior planets; but as there is no wheel-work to turn these, they are omitted in the plate. This instrument is defective in not having the diurnal motion of the Earth upon its axis shown, and the rotation of the Moon's nodes; there have been instruments made, which show all these motions, and those of the superior planets with their satellites; but they are so complicated, that it would far exceed the limits of our plates to describe them.

The numbers of the teeth of the wheels of this planetarium are not correctly calculated to produce true revolutions of the planets introduced in it, as the fixed wheel, 64, and the wheel, 64, on the axis, h, are equal; the latter, and all the wheels on h h, revolve once in a tropical year; the wheels which turn Mercury are 60, upon h, turning 14, that is $\frac{14}{60}$ of a tropical year, or 85.223185 days; this period, which is intended to be the tropical revolution of Mercury, *viz.* 87*d.* 23 *h.* 14 *m.* 35 *s.* is made the synodical revolution by the mechanism, by reason of the wheel-work being carried round the sun again in a year, by the frame, E, representing the Earth's radius vector; so that the planet Mercury goes from conjunction with the Earth to conjunction again, instead of going through the ecliptic only in this period, and the imperfection of the wheel-work is rendered still more imperfect by its position, which ought to have been on a stationary bar, to have produced the true calculated effect, this error causes it to make just one revolution in a year more than intended. The tropical period of Venus is also turned into a synodic one, by the same fault in the position of the wheel-work, besides the period itself being erroneous, *viz.* $\frac{24}{40}$ of a year, according to the original intention, which time is only 219 *d.* 3 *h.* 29 *m.* 19.8 *s.*, instead of 224 *d.* 16 *h.* 41 *m.* 30 *s.*, which is the true tropical period.

The Moon-wheels, $\frac{6}{74}$, making $12\frac{1}{3}$ lunations, or synodic revolutions, give one lunation at 29 *d.* 14 *h.* 44 *m.* 29.8 *s.*, which is greatly too long; the true period being 29 *d.* 12 *h.* 44 *m.* 3 *s.*; but $\frac{3}{37}$, making $12\frac{1}{3}$ lunations, or one in 29 *d.* 12 *h.* 20 *m.* 54 *s.*, would be much more accurate, and equally well made. Thus the instrument before us is so very inaccurate, in all respects, that it ought to have its numbers rectified, which may be done in this manner.

For Mercury, instead of $\frac{14}{60}$, (or $\frac{14}{64}$), put $\frac{20}{83}$, in which case the wheel, 63, will produce $3\frac{3}{20}$ revolutions; and the Earth's arm will carry the 20 round oval in a year, making, together, 4.15 revolutions of Mercury for one of the Earth's, which is very near the truth, producing one tropical revolution in 88 *d.* 0 *h.* 14 *m.* 38 *s.*

For Venus, instead of $\frac{24}{40}$, put $\frac{25}{40}$, and one revolution per annum will be produced by the motion of the Earth's arm, and $\frac{10}{16}$ of another by the wheels, making, together, 1.625 in each year, or one tropical revolution in 224 *d.* 18 *h.* 21 *m.* 27 *s.*

The true synodic periods are:—of Mercury, 115.877 *d.*, and of Venus, 583.923 *d.*; therefore the said periods, by the present wheel-work, are too short by more than thirty days in Mercury, and in Venus, by 364 *d.*, and upwards.

PLANIMETRY, that part of geometry which considers lines and plain figures, without considering their height or depth. See SURVEYING, &c.

PLANISPHERE, signifies a projection of the sphere, and its various circles on a plane; in which sense maps, wherein are exhibited the meridians, and other circles of the sphere, are planispheres. See MAP, SPHERE, &c.

PLANISPHERE, is more particularly used for an astronomical instrument used in observing the motions of the heavenly bodies. It consists of a projection of the celestial sphere upon a plane, representing the stars, constellations, &c. in their proper order; some being projected on the meridian, and others on the equator.

The use of the planisphere is to represent the face of the heavens for any day and hour: find, on the lesser moveable plate, the month and day proposed, and turn the plate till the given day of the month stand against the hour and minute required; and the plate will then represent the face of the

heavens, by showing what stars are then rising in the meridian, or what setting. 2. To know at what hour and minute any star rises or sets, &c. Turn the moveable plate till the given star reaches the horizon east or west, and against the given day, on the moveable plate, is the hour and minute on the exterior or immoveable one: and in the same manner may most of the problems, usually resolved by the celestial globe, be determined.

PLANT, in botany, an organic vegetable body, consisting of roots and other parts. Whether capable either of sensation, or of spontaneous motion, is not yet fully ascertained. It attaches itself to other bodies, in such a manner as to derive nourishment from them, and to propagate itself by seeds. The constituent parts of plants are the roots, stems, branches, rind, or bark, leaves, flowers, and seeds; which greatly vary, both in figure and size, according to the nature of particular trees, shrubs, &c. Their various appearances have induced botanists to divide the vegetable kingdom into orders, classes, genera, species, and varieties; for an account of which see BOTANY.

According to the Linnæan system, plants take their denominations from the sex of their flowers, in the following manner:—1. Hermaphrodite plants, are such as upon the same root bear flowers that are all hermaphrodite, as in most genera. 2. Androgynous, male and female, such as upon the same root bear both male and female flowers, as in the class Monœcia. 3. Male, such as upon the same root bear male flowers only, as in the class Diœcia. 4. Female, such as upon the same root bear female flowers only, as in the class Diœcia. 5. Polygamous, such as, either in the same individual plant, or in different individual plants of the same species, have hermaphrodite flowers, and flowers of either or both sexes, as in the class Polygamia. All plants, however minute, are propagated by seed; and so easy is their cultivation, that in many instances they may be reared by parting their roots, or depositing layers, cuttings, &c. of the parent stock in such soils as are most congenial to their nature. Hence some botanists consider them as somewhat analogous to animals; a conjecture that is strongly corroborated by the regular circulation of the sap throughout all their parts; and by the sleep of plants, or the faculty which some possess of assuming at night a position different from that in which they appear during the day. In the second volume of the Manchester Transactions, we find some speculations on the perceptive power of vegetables by Dr. Percival, who attempts to show by the several analogies of organisation, life, instinct, spontaneity, and self-motion, that plants, like animals, are endued both with the powers of perception and enjoyment. The attempt, though ingeniously supported, however, fails to convince. That there is an analogy between animals and vegetables is certain; but we cannot from thence conclude, that they either perceive or enjoy. Botanists have, it is true, derived from anatomy and physiology almost all the terms employed in the description of plants. But we cannot from thence conclude, that their organization, though it bears an analogy to that of animals, is the sign of a living principle, if to this principle we annex the idea of perception. Yet so fully is our author convinced of the truth of it, that he does not think it extravagant to suppose, that, in some future period, perception may be discovered to extend even beyond the limits now assigned to vegetable life.

Mr. Good, the learned author of the translation of Lucretius, delivered in the spring of the present year, before the Medical Society of London, a discourse "On the general Structure and Physiology of Plants compared with those of Animals, and the mutual Convertibility of their Organic Elements," which contained much interesting matter, and many curious and ingenious speculations. He began by assuming, what indeed is the basis of the sexual system, that every thing that has life is produced from an egg; that the egg of the plant is its seed. The seed is sometimes naked, and sometimes covered with a pericarp, which is of various forms and structures: the seed itself consists internally of a corculum, or little heart, and externally of a parenchymatous substance, called a cotyledon, which is necessary for the germination and future growth of the seed, and may be denominated its lungs or placentule. The corculum is the "punctum saliens" of vegetable life, and to this the cotyledon is subservient. The corcle consists of an ascending and descending part: the former is called its plumule, which gives birth to the trunk and branches; from the latter spring the root and radicles. The position of the corcle in the seed, which is always in the vicinity of the eye, is a cicatrix, or umbilicus, remaining after the separation of the funis from the pericarp, to which the seed has been attached. The first ra-

dicle elongates, and pushes into the earth, before the plumule evinces any change: like the cotyledon, the radicles consist chiefly of lymphatics and air-vessels, which serve to separate the water from the soil, in order that the oxygen may be separated from the water. Hence originates the root, the most important part of the plant. The solid parts of the trunk of the plant are the cortex, or outer bark; the liber, or inner bark; the alburnum, or soft wood; lignum, or hard wood; and medulla, or pith. These lie in concentric circles; and the trunk enlarges, by the formation of a new liber, or inner bark, every year; the whole of the liber, excepting indeed its outermost layer, which is transformed into cortex, becoming the alburnum of the next, and the alburnum becoming the lignum. Hence a mark of any sort, as the initials of a name, which has penetrated through the outer into the inner bark, must in a long process of years be transferred to the central parts of the trunk. Independently of these more solid parts of the trunk, we generally meet with some portion of parenchyma and cellular substance: the vessels contained in this may be compared to arteries and veins, air vessels and lymphatics. The lymphatics lie immediately under the cuticle, and in the cuticle, and by branching different ways are enabled to perform the alternating economy of inhalation and exhalation: below these lie the arteries, which rise immediately from the root, and communicate nutriment in a perpendicular direction: interior to these lie the reducent vessels, or veins, which are softer and more numerous, and in young shoots run down through the cellular texture and the pith. Between the arteries and veins are situated the air-vessels.

"The lymphatics of a plant may be often seen with great ease by merely stripping off the cuticle with a delicate hand, and then subjecting it to a microscope; and in the course of the examination we are also frequently able to trace the existence of a great multitude of valves, by the action of which the apertures of the lymphatics are commonly found closed. Whether the other systems of vegetable vessels possess the same mechanism, we have not been able to determine decisively; the following experiment, however, should induce us to conclude that they do. If we take the stem of a common balsamine, or of various other plants, and cut it horizontally at its lower end, and plunge it, so cut, into a decoction of Brazil wood, or any other coloured fluid, we shall perceive that the arteries, or adducent vessels, as also the air vessels, will become filled or injected by an absorption of the coloured liquor, but that the veins, or reducent vessels, will not become filled; of course evincing an obstacle in this direction to the ascent of the coloured fluid. But if we invert the stem, and in like manner cut horizontally the extremity which till now was uppermost, and plunge it so cut into the same fluid, we shall then perceive that the veins will become injected, or suffer the fluid to ascend; but that the arteries will not: proving clearly the same kind of obstacle in the course of the arteries in this direction, which was proved to exist in the veins in the opposite direction; and which reverse obstacles we can scarcely ascribe to any other cause than the existence of valves.

"By this double set of vessels, moreover, possessed of an opposite power, and acting in an opposite direction, the one to convey the sap or vegetable blood forwards, and the other to bring it backwards, we are able very sufficiently to establish the phenomenon of a circulatory system."

The author admits that no experiments, nor observations, have been able to detect the existence of muscular or nervous fibres in vegetables, but notwithstanding this in answer to those who maintain the necessity of a regular and alternate contraction and dilatation for the production of a circulatory system both in animals and vegetables, he says "still must we admit the competency of other powers to produce the same result while we reflect on the facility with which the human cutis or skin, an organ destitute of all muscular fibres whatever, contracts and relaxes generally on the application of a variety of other powers; powers different in their nature, and in their effect palpable to the external senses: whilst we recal to mind that it is contracted by austere, and relaxed by oleaginous preparations; constringed by cold, and dilated by warmth; and that the opposite passions of the mind have a still more powerful influence on the same organ, since fear, apprehension, horror, will not only freeze and corrugate the skin, but in the language of the poet, which is also the language of nature, freeze the blood itself, making

'——each particular hair to stand on end
Like quills upon the fretful porcupine:'

while hope, pleasure, agreeable expectation, smooth, soften, and expand it to an

equal degree, and, figuratively, perhaps literally, lubricate it with the oil of joy. More especially must we come to this conclusion, while in conjunction herewith, we survey, in various species of the vegetable kingdom, as strong a contractility and irritability as are to be met with in the most contractile and irritable muscles of the most sentient animals.

"Yet could it even be proved that the vessels of plants are incapable of being made to contract by any power whatever, still should we have no great difficulty in conceiving a perfect circulatory system in animals or vegetables without any such cause, whilst we reflect that one half of the circulation of the blood in man himself is accomplished without such a contrivance; and this, too, the more difficult half, as every one knows that the veins have, for the most part, to oppose the attraction of gravitation, instead of being able to take advantage of it.

"To argue, therefore, against the existence of a circulation of blood, or sap, in plants, from the single circumstance that we are not able to prove demonstrably their possession either of muscular fibres, or of a regular systole and diastole, is merely to argue *ex ignorantiâ*, and in defiance of facts and experiments which, if not absolutely decisive, are perhaps as decisive as the nature of the case will allow."

Having established this point the author proceeds to point out some striking resemblances in plants to the economy and habits of animals. To these we can but briefly allude.

Plants like animals are propagated by sexual connection: "although among vegetables we meet with a few instances of propagation by other means, as, for instance, by slips and offsets, or by buds and bulbs, the parallelism, instead of being hereby diminished, is only drawn the closer; for we meet with just as many instances of the same varieties of propagation among animals. Thus the hydra, or polype, as it is more generally called, the asterias, and several species of the leech, as the hirudo viridis, for example, are uniformly propagated by lateral sections, or instinctive slips or offsets; while almost every genus of zoophytic worms is only capable of increase by buds, bulbs, or knobs.

"The blood of plants, like that of animals, instead of being simple is compound, and consists of a great multitude of compacter corpuscles, globules for the most part, but not always globules, floating in a looser and almost diaphanous fluid. From this common current of vitality, plants, like animals, secrete a variety of substances of different, and frequently of opposite powers and qualities,—substances nutritive, medicinal, or destructive. And as in animal life, so also in vegetable, it is often observed that the very same tribe, or even individual, that in some of its organs secretes a wholesome aliment, in other organs secretes a deadly poison. As the viper pours into the reservoir situated at the bottom of his hollow tusk a fluid fatal to other animals, while in the general substance of his body he offers us not only a healthful nutriment, but, in some sort, an antidote for the venom of his jaw: so the jatropha manihot, or Indian cassava, secretes a juice extremely poisonous in its root, while its leaves are regarded as a common esculent in the country, and are eaten like spinach-leaves among ourselves.

"Animals, as we all know, are liable to a great variety of diseases; so, too, are vegetables; to diseases as numerous, as varied, and as fatal; to diseases epidemic, endemic, sporadic; to scabies, pernio, ulcer, gangrene; to polysarcia, atrophy, and, above all, to invermination. Whatever, in fine, be the system of nosology to which we are attached, it is impossible for us to put our hand upon any one class or order of diseases which they describe, without putting our hand, at the same time, upon some disease to which plants are subject in common with animals.

"There are some tribes of animals that exfoliate their cuticle annually, such are grass-hoppers, spiders, several species of crabs, and serpents. Among vegetables we meet with a similar variation from the common rule, in the shrubby cinquefoil, indigenous to Yorkshire, and the plane-tree of the West Indies. Animals are occasionally divided into the two classes of locomotive or migratory, and fixed or permanent; vegetables may partake of a similar classification. Unquestionably the greater number of animals are of the former section, yet in every order of worms we meet with some instances that naturally appertain to the latter, while almost every genus and species of the zoophytes can only be included under it. Plants, on the contrary, are for the most part stationary, yet there are many that are fairly entitled to be re-

garded as locomotive or migratory. The strawberry may be selected as a familiar example."

Plants, like animals have a wonderful power, of maintaining their common temperature whatever be the temperature of the atmosphere that surrounds them, and like animals they are found to exist, in astonishing degrees of heat and cold. Of these Mr. Good has given many curious instances. Animals are often divided into the three classes of terrestrial, aquatic and aerial. Plants are capable of a similar division. Among animals it is probable that the largest number is of the first class, but among vegetables it should seem, from the almost countless species of fuci, &c. that the largest number belongs to the submarine class. Many animals are amphibious or capable of preserving life in either element; the vegetable world is not without instances of a similar power. Animals of various kinds are aerial: all the most succulent plants of hot climates are of this description: these will only grow in soils or sands from which no moisture can be extracted: they are even destroyed by a full supply of wet by a rainy season: hence it has been supposed that they derive the whole of their nourishment from the surrounding atmosphere, and that the only advantage which they acquire from thrusting their roots into such strata is that of obtaining an erect position. Some quadrupeds seem to derive nutriment in the same manner. The bradypus, or sloth, never drinks, and trembles at the feeling of rain. Among plants possessing the same properties is the aerial epidendrum, a native of the East Indies, where it is no uncommon thing for the inhabitants to pluck it up on account of the elegance of its leaves, the beauty of its flower, and the exquisite odour it diffuses, and to suspend it by a silken cord from the cieling of their rooms, where from year to year, it continues to put forth new leaves, new blossoms, a new fragrance, excited alone to new life and action by the stimulus of the surrounding atmosphere. "That stimulus is oxygen; ammonia is a good stimulus, but oxygen possesses far superior powers, and hence without some portion of oxygen no plant can ever be made to germinate: hence to the use of cow-dung and other animal recrements, which consists of muriatic acid and ammonia, while in fat oil and other fluids that contain little or no oxygen, and consists altogether, or nearly so, of hydrogen and carbon, seeds may be confined for ages without exhibiting any germination whatever. And hence, again, and the fact deserves to be extensively known, however torpid a seed may be, and destitute of all power to vegetate in any other substance, if steeped in a diluted solution of oxygenated muriatic acid, at a temperature of about 46° or 48° of Fahrenheit, provided it still possess its principle of vitality, it will germinate in a few hours; and if, after this, it be planted, as it ought to be, in its appropriate soil, will grow with as much speed and vigour as if it had evinced no torpidity whatever."

The author next proceeds to enquire into the mode by which vegetable matter is capable of being converted into animal substance, so as not only to be perfectly assimilated to it, but to become the basis of animal nutriment and increase. "Now to be able to reply succinctly and directly to this question, it is necessary first of all to inquire into the chief feature in which animal and vegetable substances agree, and the chief feature in which they disagree.

"Animals and vegetables, then, agree in their equal necessity of extracting a certain sweet and saccharine fluid, as the basis of their support, from whatever substances may, for this purpose, be applied to their respective organs of digestion. Animal chyle and vegetable sap have a very close approximation to each other in their constituent principles, as well as in their external appearance. In this respect plants and animals agree. They disagree, inasmuch as animal substances possess a very large proportion of azote, with a very small proportion of carbon; while vegetable substances, on the contrary, possess a very large proportion of carbon, with a very small proportion of azote. And it is hence obvious, that vegetable matter can only be assimilated to animal by parting with its excess of carbon, and filling up its deficiency of azote.

"Vegetable substances, then, part first of all with a considerable portion of their excess of carbon, in the stomach and intestinal canal, during the process of digestion; a certain quantity of the carbon detaching a certain quantity of the oxygen existing in these organs, as an elementary part of the air or water they contain, in consequence of its closer affinity to oxygen, and producing carbonic acid gas; a fact which has been clearly ascertained by a variety of experiments by M. Jurine, of Geneva. A very

large surplus of carbon, however, still enters the animal system through the medium of the lacteals, and continues to circulate with the chyle, or the blood, till it reaches the lungs. Here again a considerable portion of carbon is perpetually parted with upon every expiration, in the same form of carbonic gas, in consequence of its union with a part of the oxygen introduced into the lungs with every returning inspiration; as is sufficiently established by the experiments of Mr. Davy and other celebrated chemists; while the excess, that yet remains, is carried off by the skin, in consequence of its contact with atmospheric air: a fact put beyond all doubt by the experiments and observations of M. Jurine, although, on a superficial view, opposed by a few experiments of M. Ingenhouz; and obvious to every one from the well-known circumstance, that the purest linen, upon the purest skin, in the purest atmosphere, soon becomes discoloured. In this way, then, and by this triple co-operation of the stomach, the lungs, and the skin, vegetable matter, in its conversion into animal, parts with the whole of its excess of carbon. Its deficiency of azote becomes supplied in a twofold method. First, at the lungs; also, by the process of respiration: for we uniformly find, and the experiments of Dr. Priestley and Mr. Davy are fully conclusive upon this subject, that a larger portion of azote is inhaled upon every inspiration, than is returned by every succeeding expiration; in consequence of which, the portion retained in the lungs must enter into the system, in the same manner as the retained oxygen, and perhaps in conjunction with it; while, in unison with this action of the lungs, the skin also absorbs a considerable quantity of azote, and thus completes the supply that is necessary for the animalization of vegetable food: evincing, hereby, a double consent of action in these two organs, and giving us some insight into the mode by which insects and worms, which are totally destitute of lungs, are capable of employing the skin as a substitute for lungs, by breathing through certain spiracles introduced into the skin for this purpose, or merely through the common pores of the skin, without any such additional mechanism. It is by this mode also that respiration takes place through the whole vegetable world, offering us another instance of resemblance to many parts of the animal; in consequence of which insects, worms, and the leaves of vegetables, equally perish, by being smeared over with oil, or any other viscous fluid that obstructs their cutaneous orifices.

"But to complete the great circle of universal action, and to preserve the important balance of nature in a state of equipoise, it is necessary, also, to inquire by what means animal matter is reconverted into vegetable; so as to afford to plants the same basis of nutriment which plants have previously afforded to animals."

The process of putrefaction is shown to be that principle, which is to be regarded as a most important link in the great chain of universal life and harmony. See Good's Oration.

Corallines, madrepores, millepores, and sponges, were formerly considered as fossil bodies; but the experiments of Count Marsigli evinced, that they are endued with life, and led him to class them with the maritime plants. And the observations of Ellis, Jussieu, and Peysonel, have since raised them to the rank of animals. The detection of error in long-established opinions concerning one branch of natural knowledge, justifies the suspicion of its existence in others which are nearly allied to it. And it will appear from the prosecution of an enquiry into the instincts, spontaneity, and self-moving power of vegetables, that the suspicion is not without foundation.

PLANTAGO, in botany, *plantain*, a genus of the Tetrandria Monogynia class and order. Natural order of Plantagines, Jussieu. Essential character: calyx four-cleft; corolla four-cleft, with the border reflex; stamina very long; capsule two-celled, cut transversely. There are thirty-eight species. These plants, having little beauty, are rarely cultivated, except in botanic gardens.

PLASHING *of quickset hedges*, an operation very necessary to promote the growth and continuance of old hedges. It is performed in this manner: the old stubs must be cut off, &c. within two or three inches of the ground, and the best and longest of the middle sized shoots must be left to lay down. Some of the strongest of these must also be left to answer the purpose of stakes. These are to be cut off to the height at which the hedge is intended to be left; and they are to stand at ten foot distance one from another: when there are not proper shoots for these at the due distances, their places must be supplied with common stakes of dead wood. The hedge is to be first thinned, by cutting away all but those shoots which are intended to be

used either as stakes, or the other work of the plashing; the ditch is to be cleaned out with the spade: and it must be now dug as at first, with sloping sides each way; and when there is any cavity on the bank on which the hedge grows, or the earth has been washed away from the roots of the shrubs, it is to be made good by facing it, as they express it, with the mould dug from the upper part of the ditch: all the rest of the earth dug out of the ditch is to be laid upon the top of the bank.

In plashing the quick, two extremes are to be avoided; these are, the laying it too low, and the laying it too thick: this makes the sap run all into the shoots, and leaves the plashes without sufficient nourishment; which, with the thickness of the hedge, finally kills them. The other extreme of laying them too high, is equally to be avoided; for this carries up all the nourishment into the plashes, and so makes the shoots small and weak at the bottom, and, consequently the hedge thin.

PLASMA, in mineralogy. The colour of this mineral is intermediate between grass and leek green, and of different degrees of intensity. It is marked with ochre yellow dots, and whitish spots. It occurs in angular pieces; internally it is glistening; fracture perfectly flat conchoidal. It is hard, brittle, easily frangible; not very heavy. It has been found in Italy, Germany, and Turkey, but chiefly among the ruins of Rome. It is said that it was formerly worn by the Romans as a part of ornamental dress.

PLASTER, in pharmacy, is defined to be an external application, of a harder consistence than our ointments: these are to be spread according to the different circumstances of the wound, place, or patient, either upon linen or leather. See PHARMACY.

PLASTER, among builders, &c. The plaster of Paris is a preparation of several species of gypsums, dug near Mont Maitre, a village in the neighbourhood of Paris; whence the name. See MORTAR.

PLATANUS, in botany, *plane tree*, a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Essential character: male, calyx ament globular; corolla scarcely apparent; anthers growing round the filament: female, calyx ament globular; corolla many-petalled; stigma recurved; seeds roundish, mucronate with the style, pappose at the base. There are two species, viz. P. orientalis, oriental plane tree, and P. occidentalis, American plane tree; these are very large, handsome, and lofty trees. The first sort, or eastern plane tree, grows naturally in Asia; the stem is tall, erect, and covered with a smooth bark, which annually falls off; it sends out many side branches, and are generally a little crooked at their joints; the leaves are placed alternate, on footstalks an inch and a half long; the flowers come out upon long peduncles, hanging downward, each sustaining five or six round balls of flowers; the upper, which are the largest, are more than four inches in circumference; these sit very close to the peduncle; the bristly down surrounding the seeds helps to transport them to a great distance.

PLATALEA, the *spoonbill*, in natural history, a genus of birds of the order Grallæ. Generic character: bill long, broad, flat, and thin, the end widening into a roundish form; nostrils small at the base of the bill; tongue short and pointed; feet four-toed and semi-palmated. There are three species.

P. leucerodia, or the white spoonbill, inhabits Europe, Asia, and Africa, and subsists on frogs and fishes, snakes and grass. It is of the size of a heron; it frequents the sea coasts, near which it builds in the highest trees, and, in the breeding season, is nearly as clamorous as the rook. These birds are migratory, and withdraw to warm regions on the approach of winter. Their flesh has a strong resemblance in taste to that of a goose. See Aves, Plate XII. fig. 4.

The Brazilian spoonbill is somewhat less than the above, and its plumage is nearly throughout of an exquisite rose colour.

The scarlet spoonbill, a variety of the last, is of the colour from which it is named, which, however, it does not attain till its third year. It is of the same size as the last, and found in Jamaica and Mexico.

The dwarf spoonbill is of the size of a sparrow, and inhabits South America.

PLATE, in heraldry, is a round flat piece of silver, without any impression; but as it were formed, ready to receive it.

PLATE is also a term used by our sportsmen, to express the reward given to the best horse at our races.

PLATES, in gunnery. The prise-plates are two plates of iron on the cheeks of a gun-carriage, from the cape square to the centre, through which the prise-bolts go, and on which the handspike rests when it poises up the breech of the piece. Breast-

plates are the two plates on the face of the carriage, one on each cheek. Train-plates are the two plates on the cheeks, at the train of the carriage. Dulidge-plates are the six plates on the wheel of a gun-carriage, where the fellors are joined together, and serve to strengthen the dulidges.

PLATFORM, in the military art, an elevation of earth, on which cannon is placed, to fire on the enemy; such are the mounts in the middle of curtins. On the rampart there is always a platform, where the cannon are mounted. It is made by the heaping up of earth on the rampart, or by an arrangement of madriers, rising insensibly, for the cannon to roll on, either in a casemate, or on attack in the out-works.

All practitioners are agreed, that no shot can be depended on, unless the piece can be placed on a solid platform; for if the platform shakes with the first impulse of the powder, the piece must likewise shake, which will alter its direction, and render the shot uncertain.

PLATFORM, in architecture, is a row of beams, which support the timber-work of a roof, and lie on the top of the wall, where the entablature ought to be raised. This term is also used for a kind of terrace, or broad, smooth, open walk at the top of a building, from whence a fair prospect may be taken of the adjacent country. Hence an edifice is said to be covered with a platform, when it is flat at top, and has no ridge. Most of the oriental buildings are thus covered, as were all those of the ancients.

PLATINA, or PLATINUM, a metal, which in most of its properties is equal to gold, but in others it is very superior. It was first ascertained to be a distinct metal by Scheffer, a Swedish chemist, in the year 1752. By him it was named white gold, because it resembled this metal in many of its properties. It immediately became subject to the experiments of all the chemists in Europe, and obtained, from its colour, the name of platina, signifying little silver, from the word plata, which is Spanish for silver. Platina has been found among the gold ores of South America, and more particularly in the mine of Santa Fe near Carthagena, and in the district of Choco in Peru. Platina, in the state in which it reaches this country, is contaminated by the presence of several other metals, as iridium, osmium, rhodium, and palladium, and, in fact, it is merely an ore of platina. It is in the form of small grains or scales, of a whiter colour than iron, and extremely heavy. Various processes have been contrived for its purification; but the one, which is the most simple and practicable, is described in the ninth volume of Nicholson's Journal. Platina has the following properties. It is a white metal, resembling silver in colour, but greatly exceeding it, and indeed all other metals, in specific gravity, being, when it is hammered, twenty-three or twenty-four times heavier than water. It is not oxydized by the long-continued and concurrent action of heat and air. It has the property of welding, which belongs to no other metal but this and iron. It is not acted on by any other acid than the nitro-muriatic and oxygenized muriatic. The former is best adapted to effect this solution. Sixteen parts of the compound acid are to be poured on one of the laminated metal, and exposed to heat in a glass vessel; nitrous gas is disengaged, and a reddish coloured solution is obtained, which gives a brown stain to the skin. The muriate of platina has the characteristic property of being precipitated by a solution of muriate of ammonia. By this character, platina is distinguished from all other metals, and may be separated when mingled with them in solution. The precipitate, thus obtained, is decomposed by a strong heat, and leaves pure platina. When pure potash is poured into the muriatic solution, a precipitate ensues, which is not an oxide of platina, but a triple compound of that oxide with the alkali and acid. With soda, also, it forms a triple combination.

Platina is acted upon by fusion with nitrate of potash, and also with pure fixed alkalies. The most delicate test of the presence of platina is muriate of tin. A solution of platina, so dilute as to be scarcely distinguishable from water, assumes a bright red colour, on the addition of a single drop of the recent solution of tin.

Platina has been discovered by Dr. Wollaston to be a remarkably slow conductor of caloric. When equal pieces of silver, copper, and platina, were covered with wax, and heated at one end, the wax was melted 3½ inches on the silver; 2½ on the copper, and one inch only on the platina. Its expansion by heat is considerably less than that of steel; which, between the temperatures of 32° and 212° is expanded about 12 parts in 10,000, while the expansion of platina is only about 10.

Platina combines with many of the metals, and forms with them alloys, some of

which are of considerable importance in the working of this metal. Platina forms an alloy with arsenic, which is brittle and very fusible. It is in this state of alloy that platina is susceptible of being formed into different utensils and instruments for which it is peculiarly fitted. It is first fused with this metal, and then cast into moulds, at first in the form of square plates. It is then exposed to a red heat, and hammered into bars. By the heating and hammering, the arsenic is driven off, and the metal is purified and becomes infusible, but retains its ductility, so that it may be wrought like iron. It has been found extremely difficult to combine platina and mercury. Guyton had observed that the adhesive force of platina and mercury is greater than that of metals which do not combine with it; and that it is not inferior even to those which readily form alloys; from which he conjectured that the alloy of platina and mercury might be effected by the following process. He placed a very thin plate of pure platina at the bottom of a matrass containing a quantity of mercury. The matrass was put upon a sand bath, and heat applied, till the mercury boiled and the matrass became red-hot. When the platina was taken out, it was found to have acquired additional weight, and to have become very brittle. But this combination is different from the other combinations of mercury with the metals, for the platina did not lose its solid form. M. Chenevix, in the course of experiments and researches respecting a supposed new metal called palladium, succeeded in forming an amalgam with platina and mercury. He heated purified platina in the form of fine powder, with ten times its weight of mercury, and rubbed them together for a long time. The result was an amalgam of platina, which being exposed to a violent heat, lost all the mercury it contained, and the original weight of the platina remained. Platina combines with copper by means of fusion, and gives it hardness. When the proportion of copper is three or four times greater than that of platina, the alloy is ductile, susceptible of a fine polish, and is not altered by exposure to the air. This alloy has been employed in the fabrication of mirrors for telescopes. Gold combines readily with platina, but it requires a very powerful heat for the fusion of these two metals. Platina diminishes the colour of gold, unless it be in very small quantity. When the proportion of platina is above $\frac{1}{19}$, the colour of the gold begins to be altered. There is no perceptible change in the specific gravity or the ductility of gold from this alloy.

Platina, on account of its peculiar properties, its infusibility, density, and indestructibility, could it be obtained in sufficient quantity, and at a moderate price, would undoubtedly prove one of the most useful and most important of the metals yet known. The importance and utility of platina, on account of its scarcity, have been hitherto limited to chemical purposes; and for different chemical instruments and utensils, it has been found peculiarly appropriate, as there are few chemical agents whose effects it cannot resist. There is indeed little doubt but it might be employed with equal advantage in the construction of instruments and utensils, in various arts and manufactures.

PLATING, is the art of covering baser metals with a thin plate of silver either for use or for ornament. It is said to have been invented by a spur-maker, not for show, but for real utility. Till then the more elegant spurs in common use were made of solid silver; and from the flexibility of that metal, they were liable to be bent into inconvenient forms by the slightest accident. To remedy this defect, a workman at Birmingham contrived to make the branches of a pair of spurs hollow, and to fill that hollow with a slender rod of steel or iron. Finding this a great improvement, and being desirous to add cheapness to utility, he continued to make the hollow larger, and of course the iron thicker and thicker, till at last he discovered the means of coating an iron spur with silver in such a manner as to make it equally elegant with those which were made wholly of that metal. The invention was quickly applied to other purposes; and to numberless utensils which were formerly made of brass or iron are now given the strength of these metals, and the elegance of silver, for a small additional expense. The silver plate was formerly made to adhere to the baser metal by means of solder; which is of two kinds, the soft and the hard, or the tin and silver solders. The former of these consists of tin alone, the latter generally of three parts of silver and one of brass. When a buckle, for instance, is to be plated by means of the soft solder, the ring, before it is bent, is first tinned, and then the silver plate is gently hammered upon it, the hammer employed

being always covered with a piece of cloth. The silver now forms, as it were, a mould to the ring, and whatever of it is not intended to be used is cut off. This mould is fastened to the ring of the buckle by two or three cramps of iron-wire; after which the buckle, with the plated side undermost, is laid upon a plate of iron sufficiently hot to melt the tin, but not the silver. The buckle is then covered with powdered resin, or anointed with turpentine; and lest there should be a deficiency of tin, a small portion of rolled tin is likewise melted on it. The buckle is now taken off with tongs, and commonly laid on a bed of sand; where the plate and the ring, while the solder is yet in a state of fusion, are more closely compressed by a smart stroke with a block of wood. The buckle is afterwards bent and finished.

The mode of plating at present is, to fasten plates of silver upon thicker plates of copper, and then rolling them together into thin plates. The copper is twelve times thicker than the silver, and one ounce of silver is rolled to a surface of three feet or more. The plates being thus made, they are then stamped by a single stroke into the size and form of buckles, buttons, spoons, &c.

PLATONIC *year*, or the GREAT *year*, is a period of time determined by the revolution of the equinoxes, or the space wherein the stars and constellations return to their former places, in respect of the equinoxes. The platonic year, according to Tycho Brahe, is 25,816, according to Ricciolus 25,920, and according to Cassini 24,800 years. This period once accomplished, it was an opinion among the ancients, that the world was to begin anew, and the same series of things to turn over again.

PLATONIC *philosophy*. See ACADEMICS.

PLATOON, in the military art, a small square body of forty or fifty men, drawn out of a battalion of foot, and placed between the squadrons of horse, to sustain them; or in ambuscades, straits, and defiles, where there is not room for whole battalions or regiments. Platoons are also used when they form the hollow square, to strengthen the angles. The grenadiers are generally posted in platoons.

PLATYLOBIUM, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx bell-shaped, five-cleft; the two upper segments very large and obtuse; legume pedicelled, compressed, winged at the back. There is but one species, *viz.* P. formosum, orange flat pea, a native of New South Wales, where it flowers all the year round.

PLATYPUS, in natural history, a genus of Mammalia of the order Bruta. Generic character: mouth shaped like the bill of a duck; webbed feet. The P. anatinus, or duck-billed platypus, is a native of South Wales, and constitutes a new and most curious genus of quadrupeds. See ORNITHORHYNCHUS.

PLEA, in law, that which either party alleges for himself in court. These are divided into pleas of the crown and common pleas. Pleas of the crown, are all suits in the King's name, against offences committed against his crown and dignity, or against his crown and peace. Common Pleas, are those that are held between common persons. Common Pleas, are either dilatory or pleas to the action. Pleas dilatory, are such as tend merely to delay, or put off the suit, by questioning the propriety of the remedy, rather than by denying the injury. Pleas to the action, are such as dispute the very cause of suit. Dilatory pleas must not be confounded with sham pleas, which are used for the purpose of delay, but which, if true, would go to the merits of the action, and which however they may be abused can never be avoided in practice.

PLEADINGS. Pleadings, in general, signify the allegations of parties to suits when they are put into a proper and legal form; and are distinguished in respect to the parties who plead them, by the names of bars, replications, rejoinders, sur-rejoinder, rebutters, &c.; and though the matter in the declaration or count does not properly come under the name of pleading, yet, being often comprehended in the extended sense of the word, it is generally considered under this head. This is the technical sense of the word pleading, which is vulgarly applied to the public speaking of the advocates in the courts. The necessity of reducing the proceedings into writing gives rise to a great deal of business amongst barristers, which is called special pleading, and those who are skilled in this are distinguished particularly as pleaders. Of late years persons under the degree of barristers have drawn pleadings, which are afterwards signed by barristers. These persons take very low fees, but when called

to the bar engross a great share of business. Their habits bring them closely connected with attornies.

PLEASURE and Pain, says Mr. Locke, are simple ideas, which we receive both from sensation and reflection; there being thoughts of the mind, as well as sensations, accompanied with pleasure or pain.

PLECTRANTHUS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx upper segment larger; corolla resupine, gibbous or spurred at the base; filaments simple. There are five species, natives of Africa and Arabia Felix.

PLECTRONIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rhamni, Jussieu. Essential character: petals five, inserted into the throat of the calyx; berry two-seeded, inferior. There is but one species, viz. P. ventosa, a native of the Cape of Good Hope.

PLEIADES, in astronomy, an assemblage of seven stars in the neck of the constellation Taurus, the bull; although there are now only six of them visible to the naked eye. The largest is of the third magnitude, called "lucido pleiadum."

PLENUM, in physics, denotes, according to the Cartesians, that state of things wherein every part of space is supposed to be full of matter; in opposition to a vacuum.

PLENUS *flos*, in botany, *a full flower*; a term expressive of the highest degree of luxuriance in flowers. The petals in full flowers are so multiplied as to exclude all the stamina, and frequently to choak up the female organ, so that such flowers, though delightful to the eye, are vegetable monsters. Flowers with more than one petal are most liable to this; such are the ranunculus, anemony, poppy, myrtle, &c. &c. Flowers with one petal only are but seldom subject to this fulness; these, however, are not totally exempt, as may be seen in the double polyanthus, hyacinth, crocus, &c. In flowers with one petal, the mode of luxuriance, or impletion, is by a multiplication of the divisions of the limb, or upper part. In flowers with more than one petal by a multiplication of the petals or nectarium.

PLEURISY, in medicine, a violent pain in the side, attended with an acute fever, a cough, and a difficulty of breathing.

PLEURONECTES, the *flounder*, in natural history, a genus of fishes of the order Thoracici. Generic character: the eyes spherical, and both on the same side of the head; mouth arched; body compressed, one side representing the back, and the other the abdomen. In this genus are comprehended all that are commonly denominated flat fish. They swim obliquely, and are observed generally at the bottom of the water, being destitute of the air bladder. They often ingulph themselves in sands as far as the head, and thus elude the attacks of many enemies. The eyes of some of this genus are towards the right when the fish presents its abdomen to the spectator, and those of others towards the left. This difference constitutes the principal division of this genus.

P. hippoglossus, or the holibut, is one of the largest of fishes, being sometimes found of four hundred pounds weight. It subsists on smaller fishes, and on various kinds of crabs and shell fish. It is considered as rather coarse for the table when particularly large, and the part nearest the fins is thought by far preferable to any other. It is found in the European and North American seas.

The P. platessa, or plaise, is distinguishable from the other species, by being marked on the body and fins by numerous orange coloured spots. This fish inhabits the same seas as the former, and is sometimes taken of the weight of fifteen pounds, though one of eight is considered in this island as very large. The best of these fishes abound on the Sussex coast. They are in considerable estimation, and are thought preferable when of a moderate size. They subsist on the same food as the former.

The P. limanda, or dab, inhabits the same seas, but is far less common. It is much smaller than the last, but thought far more delicate for the table. It is in the greatest perfection in the spring months.

P. flesus, or the flounder, is formed much like the plaise, but is smaller, and destitute of the orange spots; it inhabits the same seas, and abounds on the British coasts, and frequently ascends the rivers to a considerable height.

P. solea, or the sole, is found in the European and American seas, and is sometimes two feet long, and eight pounds in weight; but in general very considerably smaller. Its scales may be distinguished by the microscope for their peculiar elegance of structure. Soles are fond of lying at the bottom of the waters which they

frequent, and are caught by trawl nets. Their flesh is extremely firm and rich, and is preferred to that of any other species but the turbot. They are taken in the greatest abundance near Brixham, in Devonshire.

P. tuberculatus, or P. maximus, the turbot, is broader and squarer than the above species, has a skin apparently wrinkled, and covered with numerous obtuse, unequal, spinous tubercles. It occasionally attains the weight of thirty pounds, and though called by Linnæus the largest of the genus, is extremely inferior in size to the holibut. Its flesh, however, is more valued than that of any other species, and is considered as a high and luxurious delicacy. It is found in the same seas, and subsists on the same food as the species above mentioned. On the coast of Holland these fishes are caught in great abundance by baits of herrings, haddocks, and particularly of lampreys, which are exported from Mortlake, in this country, for that purpose, to the number of nearly half a million per annum, and the value of seven or eight hundred pounds. In England, Scarborough is the principal station of the turbot fishery, which is conducted in vessels of a ton burden, in which three men carry each three distinct lines, hooked and baited, which altogether, when let down into the water, fixed at both extremities by stones, as anchors, extend sometimes to the length of three miles, always across the tide, and contain between two and three thousand hooks. At every turn of the tide they are drawn up. This fishery is attended with great danger, notwithstanding the admirable construction of the boats, or cobles, as storms come on with extreme celerity, and scarcely admitting the opportunity of escaping to the shore from a sea which exhibits suddenly the most mountainous and overwhelming billows. This, and all the above species, have their eyes on the right side.

PLINIA, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: calyx five or four-parted; petals five or four; drupe superior, grooved. There are two species, *viz.* P. crocea, saffron fruited plinia, and P. pedunculata, red fruited plinia.

PLINTH, in architecture, a flat square member, in the form of a brick. It is used as the foundation of columns, being that flat square table, under the moulding of the base and pedestal at the bottom of the whole order. It seems to have been originally intended to keep the bottom of the original wooden pillars from rotting.

PLINTH *of a statue, &c.* is a base, either flat, round, or square, that serves to support it.

PLINTH *of a wall*, denotes two or three rows of bricks advancing out from a wall; or, in general, any flat high moulding, that serves in a front wall to mark the floors, to sustain the eaves of a wall, or the larmier of a chimney.

PLOCAMA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-toothed, superior; corolla bell-shaped, five-cleft; berry three-celled; cells one-seeded. There is but one species, *viz.* P. pendula, pendulous plocama, a native of the Canary Islands.

PLOT, in dramatic poetry, is sometimes used for the fable of a tragedy or comedy, but more particularly the knot or intrigue, which makes the embarras of any piece. The unravelling puts an end to the plot.

PLOT, in surveying, the plan or draught of any field, farm, or manor surveyed with an instrument, and laid down in the proper figure and dimensions.

PLOTTING, among surveyors, is the art of laying down on paper, &c. the several angles and lines of a tract of ground surveyed by a theodolite, &c. and a chain. In surveying with the plain table, the plotting is saved; the several angles and distances being laid down on the spot, as fast as they are taken. See PLAIN-TABLE. But, in working with the theodolite, semicircle, or circumferentor, the angles are taken in degrees; and the distances in chains and links, so that there remains an after-operation to reduce these members into lines, and so to form a draught, plan, or map; this operation is called plotting. Plotting then is performed by means of two instruments, the protractor and plotting scale. By the first, the several angles observed in the field with a theodolite, or the like, and entered down in degrees in the field book, are protracted on paper in their just quantity. By the latter, the several distances measured with the chain, and entered down in the like manner in the field book, are laid down in their just proportion. See SURVEYING.

PLOTTING-*scale*, a mathematical instrument, usually of wood, sometimes of brass, or other matter; and either a foot or half a foot long. On one side of the instrument are seven several scales, or lines, divided

into equal parts. The first division of the first scale is subdivided into ten equal parts, to which is prefixed the number 10, signifying that ten of these subdivisions make an inch; or that the divisions of that scale are decimals of inches. The first division of the second scale is likewise subdivided into 10, to which is prefixed the number 16, denoting that sixteen of these subdivisions make an inch. The first division of the third scale is subdivided in like manner into 10, to which is prefixed the number 20; to that of the fourth scale is prefixed the number 24; to that of the fifth, 32; that of the sixth, 40; that of the seventh, 48; denoting the number of subdivisions equal to an inch, in each, respectively. The two last scales are broken off to make room for two lines of chords. There is also on the back side of the instrument a diagonal scale.

As to the use of the plotting, if we were required to lay down any distance upon paper, suppose 6 chains 50 links: draw an indefinite line; then setting one foot of the compasses at figure 6 on the scale, *e. gr.* the scale of 20 in an inch, extend the other to 5 of the subdivisions, for the 50 links: this distance, being transferred to the line, will exhibit the 6 chains 50 links required.

If it be desired to have 6 chains 50 links take up more or less space, take them off from a greater or lesser scale, *i. e.* from a scale that has more or fewer divisions in an inch.

To find the chains and links contained in a right line, *e. gr.* that is just drawn, according to any scale, *e. gr.* that of 20 in an inch. Take the length of the line in the compasses, and applying it to the given scale, you will find it extend from the number 6 of the great divisions to 5 of the small ones: hence the given line contains 6 chains 50 links.

PLOTUS, the *darter*, in natural history, a genus of birds of the order Anseres. Generic character: bill strait, pointed toothed; nostrils, a slit near the base; face and chin without feathers; legs short; toes four, and all webbed. There are three species. P. anhinga, or the white bellied darter, is of the size of a mallard, but measures nearly three feet in length. It is found in Brazil; builds in trees, and roosts in them at night, though living chiefly on fishes. In catching these its manner resembles that of serpents. Drawing up its neck, it darts on its prey with its bill, and catches it in its claws. It is rarely seen on the ground, and, when not on the water in the pursuit of its food, it is to be seen on the most elevated trees, where it sits with its head drawn in between the shoulders. Its flesh is rank and oily. The black-bellied anhinga is found in Ceylon and Java, and darting its long neck through the low shrubs immediately over the water, is, on the first view, mistaken frequently for some venomous reptile, and excites corresponding agitation and terror. The Surinam darter is of the size of a teal, and feeds on flies as well as fishes and water insects; and in every attempt at destroying a fly by the dart of its bill it has been observed to succeed for a long continued time. It is often domesticated, and is called the sun-bird, from the circumstance, probably, of its often developing at once its tail and wings, and thus exhibiting a circular appearance of plumage, which, however, is certainly by no means glowing and ardent.

PLOUGH, in agriculture, a machine for turning up the soil, contrived to save the time, labour, and expence that without this instrument must have been employed in digging land, to prepare it for the sowing of all kinds of grain. See AGRICULTURE.

PLOUGH, among bookbinders, is a machine for cutting the edges of the leaves of books smooth.

PLUKENETIA, in botany, so named from Leonard Plukenet, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx none; petals four: male, stamens eight; nectaries four, bearded: female, style very long, with a peltate, four-lobed stigma; capsule four-grained. There is but one species; *viz.* P. volubilis, a native of both Indies.

PLUM-*tree*. See PRUNUS.

PLUMB-*line*, among artificers, denotes a perpendicular to the horizon; so called as being commonly erected by means of a plummet.

PLUMBAGO, in botany, *lead-wort*, a genus of the Pentandria Monogynia class and order. Natural order of Plumbagines, Jussieu. Essential character: corolla funnel-form; stamens inserted into scales inclosing the base of the corolla; stigma five-cleft; seed one, oblong, tunicated. There are seven species.

PLUMBAGO, in chemistry, a carburet of iron. See IRON.

PLUMBERY, the art of casting and working lead, and using it in buildings, &c. As this metal melts very readily, it is easy to cast it into figures of any kind, by running it into moulds of brass, clay, plaster, &c.

But the chief articles in plumbery are sheets and pipes of lead; and as these make the basis of the plumber's work, we shall here give the process of making them. In casting sheet-lead, a table or mould is made use of, which consists of large pieces of wood well jointed, and bound with bars of iron at the ends, on the sides of which runs a frame, consisting of a ledge, or border of wood, two or three inches thick, and two or three inches high from the mould, called the sharps: the ordinary width of the mould, within these sharps, is from three to four feet; and its length is sixteen, seventeen, or eighteen feet. This should be something longer than the sheets are intended to be, in order that the end where the metal runs off from the mould may be cut off, because it is commonly thin, or uneven, or ragged at the end. It must stand very even or level in breadth, and something falling from the end in which the metal is poured in, *viz.* about an inch, or an inch and a half, in the length of sixteen or seventeen inches. At the upper end of the mould stands the pan, which is a concave triangular prism, composed of two planks nailed together at right angles, and two triangular pieces fitted in between them at the ends. The length of this pan is the whole breadth of the mould in which the sheets are cast; it stands with its bottom, which is a sharp edge, on a form at the end of the mould, leaning with one side against it, and on the opposite side is a handle to lift it up by, to pour out the melted lead; and on that side of the pan next the mould are two iron hooks to take hold of the mould, and prevent the pan from slipping, while the melted lead is pouring out of it into the mould. This pan is lined on the inside with moistened sand, to prevent it from being fired by the hot metal. The mould is also spread over, about two-thirds of an inch thick, with sand sifted and moistened, which is rendered perfectly level by moving over it a piece of wood called a strike, by trampling upon it with the feet, and smoothing it over with a smoothing plane, which is a thick plate of polished brass, about nine inches square, turned up on all the four edges, and with a handle fitted on the upper or concave side. The sand being thus smoothed, it is fit for casting sheets of lead; but if they would cast a cistern, they measure out the bigness of the four sides, and having taken the dimensions of the front, or fore-part, make mouldings by pressing long slips of wood, which contain the same mouldings into the level sand, and form the figures of birds, beasts, &c. by pressing in the same manner leaden figures upon it, and then taking them off, and at the same time smoothing the surface where any of the sand is raised up, by making these impressions upon it.

The rest of the operation is the same in casting either cisterns or plain sheets of lead; but before we proceed to mention the manner in which that is performed, it will be necessary to give a more particular description of the strike. The strike, then, is a piece of board about five inches broad, and something longer than the breadth of the mould on the inside; and at each end is cut a notch about two inches deep, so that when it is used, it rides upon the sharps with those notches. Before they begin to cast, the strike is made ready by tacking on two pieces of an old hat on the notches, or by slipping a case of leather over each end, in order to raise the under side about one eighth of an inch, or something more, above the sand, according as they would have the sheet to be in thickness; then they tallow the under edge of the strike, and lay it across the mould. The lead being melted, it is ladled into the pan, in which, when there is a sufficient quantity for the present purpose, the scum of the metal is swept off with a piece of board to the edge of the pan, letting it settle on the sand, which is by this means prevented from falling into the mould at the pouring out of the metal. When the lead is cool enough, which is known by its beginning to stand with a shell or wall on the sand round the pan; two men take the pan by the handle, or else one of them lifts it up by a bar and chain fixed to a beam in the ceiling, and pour it into the mould, while another man stands ready with the strike, and, as soon as they have done pouring in the metal, puts on the mould, sweeps the lead forward, and draws the overplus into a trough prepared to receive it. The sheets being thus cast, nothing remains but to planish the edges, in order to render them smooth and straight; but if it be a cistern, it is bent into four sides, so that the two ends may join the back, where they are soldered together, after which the bottom is soldered up.

The Method of casting thin Sheets of Lead. Instead of sand, they cover the mould with a piece of woollen stuff nailed down at the two ends to keep it tight, and over this lay a very fine linen cloth. In this process great regard is had to the just degree

of heat, so as that the lead may run well, and yet not burn the linen. This they judge of by a piece of paper, for it takes fire in the liquid lead if it is too hot, and if it be not shrunk and scorched a little, it is not hot enough.

The Method of casting Pipes without soldering. To make these pipes they have a kind of little mill, with arms or levers to turn it withal. The moulds are of brass, and consist of two pieces, which open and shut by means of hooks and hinges, their inward calibre, or diameter, being according to the size of the pipe to be made, and their length is usually two feet and a half. In the middle is placed a core, or round piece of brass or iron, somewhat longer than the mould, and of the thickness of the inward diameter of the pipe. This core is passed through two copper-rundles, one at each end of the mould, which they serve to close; and to these is joined a little copper-tube, about two inches long, and of the thickness the leaden pipe is intended to be of. By means of these tubes the core is retained in the middle of the cavity of the mould. The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace, they take it up in a ladle, and pour it into the mould by a little aperture at one end, made in the form of a funnel. When the mould is full, they pass a hook into the end of the core, and, turning the mill, draw it out; and then, opening the mould, take out the pipe. If they desire to have the pipe lengthened, they put one end of it in the lower end of the mould, and pass the end of the core into it; then shut the mould again, and apply its rundle and tube as before, the pipe just cast serving for rundle, &c. at the other end. Things being thus replaced, they pour in fresh metal, and repeat the operation till they have got a pipe of the length required. For making pipes of sheet-lead, the plumbers have wooden cylinders, of the length and thickness required, and on these they form their pipes by wrapping the sheet around them, and soldering up the edges all along them.

PLUME, a set or bunch of ostrich feathers, pulled out of the tail and wings, and made up to serve for ornaments in funerals, &c. Among sportsmen, plume is the general colour or mixture of the feathers of a hawk, which shows her constitution.

PLUMERIA, in botany, so named in honour of Charles Plumier; a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, reflex; seeds inserted into their proper membrane. There are four species.

PLUMMET, PLUMB-RULE, or PLUMB-LINE, an instrument used by carpenters, masons, &c. in order to judge whether walls, &c. be upright planes, horizontal, or the like. It is thus called from a piece of lead, "plumbum," fastened to the end of a cord, which usually constitutes this instrument. Sometimes the string descends along a wooden ruler, &c. raised perpendicularly on another; in which case it becomes a level. See LEVEL.

PLUMMING, among miners, is the method of using a mine-dial, in order to know the exact place of the work where to sink down an air-shaft, or to bring an adit to the work, or to know which way the load inclines when any flexure happens in it. It is performed in this manner: a skilful person, with an assistant, and with pen, ink, and paper, and a long line, and a sun-dial, after his guess of the place above ground, descends into the adit or work, and there fastens one end of the line to some fixed thing in it, then the incited needle is let to rest, and the exact point where it rests is marked with a pen: he then goes on further in the line still fastened, and at the next flexure of the adit he makes a mark on the line by a knot or otherwise; and then letting down the dial again, he there likewise notes down that point at which the needle stands in this second position. In this manner he proceeds from turning to turning, marking down the points, and marking the line, till he comes to the intended place; this done, he ascends and begins to work on the surface of the earth what he did in the adit, bringing the first knot in the line to such a place where the mark of the place of the needle will again answer its pointing, and continues this till he comes to the desired place above ground, which is certain to be perpendicularly over the part of the mine into which the air-shaft is to be sunk.

PLUMULA, in botany, a little feather, the scaly part of the corculum, or embryo plant within the seed, which ascends and becomes the stem or trunk. It extends itself into the cavity of the lobes, and is terminated by a small branch resembling a feather, from which it derives its name.

PLUNGER, in mechanics, a solid brass cylinder, used as a forcer in forcing pumps.

PLURAL, in grammar, an epithet applied to that number of nouns and verbs which is used when we speak of more than one thing; or that which expresses a plurality or number of things. See GRAMMAR.

PLURALITY. In ecclesiastical matters, no person having one benefice, with cure of souls, of 8*l.* a year, in the King's books, shall accept another; but the former benefice shall be void, unless the person has a dispensation from the Archbishop of Canterbury, who has power to grant dispensations to chaplains of noblemen and others, under proper qualifications, to hold two livings, provided they are not more than thirty miles distant from each other; and provided that he reside in each, for a reasonable time, every year; and that the parson keep a sufficient curate in that in which he does not ordinarily reside.

PLUS, in algebra, a character marked thus, +, used for the sign of addition.

PLUSH, in commerce, &c. a kind of stuff having a sort of velvet knap, or shag, on one side, composed regularly of a woof of a single woollen thread and a double warp, the one wool, of two threads twisted, the other goat's or camel's hair; though there are some plushes entirely of worsted, and others composed wholly of hair. Plush is manufactured, like velvet, on a loom with three treadles; two of these separate and depress the woollen warp, and the third raises the hair warp, upon which the workman throwing the shuttle, passes the woof between the woollen and hair warp; and afterwards laying a brass broach, or needle, under that of the hair, he cuts it thereon with a knife destined for that use; conducting the knife on the broach, which is made a little hollow all its length; and thus gives the surface of the plush an appearance of velvet. See VELVET.

PLUVIAMETER. See RAIN *gauge*.

PNEUMATICS, is that branch of natural philosophy which treats of the weight, pressure, and elasticity of the air, with the effects arising from them.

Galileo, whose name is presented as of itself, whenever the enquiry relates to the first researches concerning gravity, had verified that of the air, which was denied almost universally before him, though it had been discovered by some few philosophers of antiquity. This celebrated philosopher having injected air into a glass vessel, so that it there remained compressed, found that the vessel weighed more than when the contained air was in its natural state. He inquired also, by another experiment, into the heaviness of this fluid compared with that of water; but he found it only in the ratio of 1 to 400, which is much too small, as we shall soon see. The pneumatic machine, or air-pump, was not then known. It is to Otto Guericke, a burgo-master of Magdeburg, that we are indebted for the invention of this elegant machine, which is not, like many others, confined to one part of experimental philosophy, for almost all branches derive aid from it. This machine, which will be presently described, when reduced to its greatest simplicity, is composed of a vertical cylinder of brass, in which a piston is moved; its upper base carries a cock, above which is soldered a circular brass plate situated horizontally. On this plate the receiver is placed from which we would exhaust the air, which is executed by making the piston descend and ascend alternately. By the use of this instrument, the gravity of the air has been verified, by first weighing a ball or bladder full of air, and then weighing it, after the ball or bladder has been exhausted of the air: a sensible diminution will be perceived in the weight of the ball. Philosophers have attempted likewise to determine, with precision, the specific gravity of the air.

According to the results of Deluc, the ratio between the weight of common air and distilled water, at the temperature of thawing ice, and under a medium pressure of 29.9 English inches of mercury, is that of 1 to 760; and from the experiments of Lavoisier, it follows that a cubic inch of air, taken at 10 degrees of Reaumur, weighs 0.46005 grains, and that the weight of a cubic foot of the same fluid is one ounce, three drams, and three grains: but by some very accurate experiments of Mr. Cavendish, it was ascertained that the weight of water is to that of air as 800 to 1: this was the case when the barometer stood at $29\frac{3}{4}$ inches, and the thermometer at 50°. Sir George Shuckburgh found it to be as 836 to 1, when the barometer was 29.37, and the thermometer at 51°. The medium of many experiments by the gentlemen already mentioned, and by Mr. Hauksbee, Dr. Halley, Mr. Cotes, and other philosophers equally zealous in the improvements of natural science, is about 832 to 1, when the barometer is 30°, and the thermometer 55°: this ratio must vary in proportion to the changes in the height of the barometer, and it varies also $\frac{1}{420}$th part for every de-

gree of the thermometer above or below temperature: hence the cubic foot of air, of water, and of quicksilver, may be taken as 1¼ ounce, 1000 ounces, and 13,600 ounces.

The gravity of the air being once known, it should seem that it could not be difficult to infer that the ascent of water, in the body of a pump, must be occasioned by the pressure of that fluid. This, however, was not the case: Galileo had no notion of it.

Some Italian conduit-makers being asked if they would construct sucking-pumps, whose tubes should be more than 33 feet in height, remarked, with surprise, that the water refused to rise above that limit. They requested of Galileo the explication of this singular fact; and it is affirmed that the philosopher, being taken unawares, replied that nature did not entertain the horror of a vacuum beyond 33 feet. Torricelli, a disciple of Galileo, having meditated upon this phenomenon, conjectured that water is elevated in pumps by the pressure of the exterior air; and that this pressure has only the degree of force necessary to counterbalance the weight of a column of water of 33 feet. He verified this conjecture by an experiment, for which natural philosophy owes him a double obligation, since it serves to render evident an important discovery, while it has procured us the barometer. Torricelli saw the mercury stand 29 or 30 inches in a glass tube, sealed at its upper part, and situated vertically; and the height thus under consideration being to that of 33 feet in the inverse ratio of the densities of water and of mercury; he concluded that the phenomenon belonged to statics, and that it was really, as he had conjectured, the pressure of the air which caused water or mercury to rise until an equilibrium was produced: this occurred in 1643. The year following, the news of Torricelli's experiment was disseminated in France by a letter written from Italy to Father Mersenne. The experiment was performed again in 1646, by Mersenne and Pascal; and the latter devised, in 1647, a method of rendering it still more decisive by making it at different altitudes. He invited, in consequence, his friend Perrier to repeat the experiment upon the mountain Puy-de-Dome, and to observe whether the column of mercury would descend in the tube in proportion as it became more elevated. We may see from the letter of Pascal to Perrier, where he seems to avoid the name of Torricelli, that he had not yet entirely renounced the chimera of the horror at a vacuum which was attributed to nature, and that by admitting that this horror was not invincible, he was not bold enough to assert that it never obtained. The success of the experiment completely removed the delusion. Yet this experiment was only a confirmation of that by Torricelli, and therefore yielded an additional ray to the stream of light which issued from it. The pressure of the atmosphere, upon a given surface, being nearly the same as would be exerted upon that surface by a column of water of 33 feet high; from this datum has been computed the effect of the pressure under consideration, with respect to a man of medium magnitude, and it has been found that it is equivalent to a weight of about 33,600 pounds. Considerable as this weight is, its pressure is exerted, unknown to us, because it is continually balanced by the re-action of the elastic fluids comprised in the interior cavities of our bodies; and though the air is subject to continual variations, which augment or diminish its density, in consequence of changes of temperature, and of the action of different natural causes, yet as these variations are generally confined within narrow limits, and succeed each other with comparative tardiness, they do not affect us commonly, except in a manner scarcely perceptible. But if there happen a sudden change, as when a man is raised to great heights, the rupture of the equilibrium which ensues has a very marked influence upon the animal economy. He then experiences an extreme fatigue, an absolute inability to continue his progress, a drowsiness under which he sinks in spite of himself; the respiration becomes thick and difficult; the pulsations take an accelerated motion. To explain these effects, it must be considered that the state of well-being, in all that depends upon respiration, requires that a determinate quantity of air should pass through the lungs in a given time. If, therefore, the air that we respire becomes much more rare, the inspirations must of necessity be proportionally more frequent; which will render the respiration more difficult, and will occasion the various symptoms to which we have referred. With regard to the inconveniences that would result from an air too condensed, man is not exposed to them by the action of natural causes; and it appears that, in general, they are less than those which are caused by the rarefaction of the air.

We need only cite here, as a proof of the

small magnitude of these inconveniences, that which happens to divers, when they have been shut up within a bell which descended vertically in the water, and in which the air, pressed by the weight of the surrounding columns, contracts itself more and more, in proportion as the vessel is found at a greater depth. The accidents which have occurred to those who have continued for a certain time under the bell, have arisen in great part from the alteration produced in the air by respiration, and that which was most dangerous in this fluid was the defect of renewing it. See DIVING *bell*, BAROMETER, &c.

The elasticity of the air, is verified by several well-known experiments. One of the most ordinary is that in which we employ the machine called the artificial fountain. It consists of a metallic vessel of a rounded form, its summit being pierced with an orifice, through which the vessel may be filled with water to about two-thirds of its capacity. In this aperture a tube is then fixed, which descends into the vessel until it is within a little distance of the bottom, while its upper part, which projects from the orifice, is furnished with a cock. To this same part a forcing pump is adapted, and the cock being opened, a great quantity of air is injected into the vessel: this air, being lighter than water, rises above it, and its elasticity augments with its density, in proportion as new strokes are given to the piston. Then after closing the cock, the pump is removed, and a kind of little hollow cone is substituted for it, open at its summit, which is turned upwards; as soon as the cock is again opened, the condensed air exerts its force upon the surface of the water, and drives it through the canal that is immersed into that liquid, whence it is seen to shoot out, under the form of a jet of more than twenty or thirty feet in height. An analogous effect may be obtained, solely by diminishing the natural elasticity of the air, by placing under the receiver of an air-pump a little vessel, in which all is similar to what the artificial fountain presents at the moment when the cock is opened to give a free passage to the water, except that the air situated above this liquid is in its ordinary state.

While the exhaustion is going on, the air included in the vessel, and whose pressure upon the water is no longer balanced by that of the exterior air, dilates itself, and gives birth to a jet which rises under the receiver. (See fig. 5). But the most interesting experiment relative to this object is that of Boyle, and of Mariotte, to show that the air contracts itself nearly in the ratio of the weights with which it is pressed. These kinds of experiments merit the preference, since they are not confined to merely proving the existence of a phenomenon, but make known also how it exists, by determining the law to which it is subject. Take a glass tube *a b* (Plate Pneumatics, fig. 1), bent into two branches, the shortest of which is about twelve inches high; it must be equally thick throughout, and hermetically sealed at its extremity *b*. The other branch, which is open at *a*, should be at least five feet, but if it were eight feet in height, so much the better. The whole is fixed upon a plate which carries divisions adapted to the two tubes. First, let there be poured into the bent part a little mercury, to obtain a line of level, *x z*, that we may estimate the number of degrees comprised between that line and the superior extremity of the shortest branch. In this state of things the air which occupies that branch maintains an equilibrium by its elasticity, with the pressure of the column of atmospheric air gravitating in the other branch, and whose pressure is transmitted by means of the mercury comprised in the inferior curvature. This pressure, as we have seen in the article BAROMETER, is equal to that of a mercurial column of about twenty-nine or thirty inches in height. Afterwards, let mercury be poured into the longest branch, and at the same time the air in the other branch will be condensed; by the excess of the resulting pressure the mercury will rise in the shorter branch until an equilibrium is again produced. Then measure, on one part, the length of that column of compressed air, and on the other the excess of the column of mercury contained in the longest branch, above that which occupies the shortest. We will suppose, for more simplicity, that this excess is equal to thirty inches; in that case, we shall find that the column of compressed air is reduced to the half of the height which it occupied previously to the introduction of the fresh mercury. But that column is charged with a weight double of the former, since a pressure of thirty inches of mercury is added to an equal pressure exerted by the atmospheric air, and which is not considered as being diminished; for we may neglect the small difference which results from this, that the thirty inches

which terminate the atmospheric column at bottom are actually occupied by the mercury. In general, if we take the ratio between the first pressure from the column of the atmosphere, and any other pressure whatever exerted by that same column, and by the mercury superadded, the corresponding spaces, occupied by the compressed air, will be respectively in the inverse ratio of the pressures; whence it is obvious, that the air contracts itself, as we have stated, in proportion to the weights compressing it. If we afterwards take out the mercury at several distinct times, the air will expand by reason of its elasticity, and the spaces which it will successively occupy in a contrary order will still conform to the inverse ratio of the pressures.

Having given this brief account of the general properties of air, we shall refer to a few experiments, and the instruments which are commonly used in performing these experiments; beginning with the air-pump, which has been already described in a general way. Fig. 2, is an air pump, much in use. A A are two brass barrels, each containing a piston, with a valve opening upwards. They are worked by means of the winch, B, which has a pinion that fits into the teeth of the racks, C C, which are made upon the ends of the pistons, and by this means moves them up and down alternately. On the square wooden frame, D E, there is placed a brass plate, G, ground perfectly flat, and also a brass tube, let into the wood communicating with the two cylinders and the cock, I, and opening into the centre of the brass plate at *a*. The glass vessel, K, to be emptied or exhausted of air, has its rim ground quite flat, and rubbed with a little pomatum, or hog's lard, to make it fit more closely upon the brass plate of the pump. Sometimes thin slips of moistened leather are used for this purpose. These vessels are called receivers. Having shut the cock, I, the pistons are worked by the winch, and the air being suffered to escape when the piston is forced down, because the valve opens upwards, but prevented from returning into the vessel, for the same reason the receiver is gradually exhausted, and will then be fixed fast upon the pump-plate. By opening the cock, I, the air rushes again into the receiver.

To the air pump is attached the gauge, *s*, or instrument for measuring the degree of rarefaction, or exhaustion, produced in the receiver, and which is a necessary appendage to the air-pump. If a barometer be included beneath the receiver, the mercury will stand at the same height as in the open air, but when the receiver begins to be exhausted, the mercury will descend, and rest at a height, which is, in proportion to its former height, as the spring of the air remaining in the receiver is to its spring before exhaustion. Thus, if the height of the mercury, after exhaustion, is the thousandth part of what it was before, we say that the air in the receiver rarefied is a thousand times. On account of the inconvenience of including a barometer in a receiver, a tube, of six or eight inches in length, is filled with mercury, and inverted in the same manner as the barometer. This being included, answers the same purpose, with no other difference, than that the mercury does not begin to descend till after about three-fourths of the air is exhausted: it is called the short barometer gauge. This is generally placed detached, but communicating with the receiver by a tube concealed in the frame, as is represented in the figure; another and better guage was invented by Mr. Smeaton, and called from its form, the pear-guage. It consists of a glass vessel, in the form of a pear (fig. 3), and sufficient to hold about half a pound of mercury: it is open at one end, and at the other end is a tube hermetically closed at top. The tube is graduated, so as to represent proportionate parts of the whole capacity. This gauge, during the exhaustion of the receiver, is suspended in it by a slip wire, over a cistern of mercury, placed also in the receiver. When the pump is worked as much as is thought necessary, the gauge is let down into the mercury, and the air re-admitted. The mercury will immediately rise in the gauge; but if any air remained in the receiver, a certain portion of it would be in the guage; and as it would occupy the top of the tube above the mercury, it would shew by its size the degree of exhaustion; for the bubble of air would be to the whole contents of the gauge, as the quantity of air in the exhausted receiver would to an equal volume of the common atmospheric air. If the receiver contained any elastic vapour generated during the rarefaction, it would be condensed upon the re-admission of the atmospheric air, as it cannot subsist in the usual pressure. The pear-gauge, therefore, shows the true quantity of atmospheric air left in the receiver. Hence it will sometimes indicate that all the permanent air is exhausted from the

receiver, except about $\frac{1}{100000}$ part, when the other gauges do not shew a degree of exhaustion of more than two hundred times, and sometimes much less.

When the receiver is placed upon the plate of the air-pump without exhausting it, it may be removed again with the utmost facility, because there is a mass of air under it, that resists, by its elasticity, the pressure on the outside; but exhaust the receiver, thus removing the counter pressure, and it will be held down to the plate by the weight of the air upon it. What the pressure of the air amounts to, is exactly determined in the following manner: when the surface of a fluid is exposed to the air, it is pressed by the weight of the atmosphere equally on every part, and consequently remains at rest. But if the pressure be removed from any particular part, the fluid must yield in that part, and be forced out of its situation.

Into the receiver A, (fig. 4), put a small vessel with quicksilver, or any other fluid, and through the collar of leathers at B, suspend a glass tube, hermetically sealed, over the small vessel. Having exhausted the receiver, let down the tube into the quicksilver, which will not rise into the tube as long as the receiver continues empty. But re-admit the air, and the quicksilver will immediately ascend. The reason of this is, that upon exhausting the receiver, the tube is likewise emptied of air; and therefore, when it is immersed in the quicksilver, and the air re-admitted into the receiver, all the surface of the quicksilver is pressed upon by the air, except that portion which lies above the orifice of the tube: consequently, it must rise in the tube, and continue so to do, until the weight of the elevated quicksilver press as forcibly on that portion which lies beneath the tube, as the weight of the air does on every other equal portion without the tube.

Take a common syringe of any kind, and having pushed the piston to the furthest end, immerse it into water; then draw up the piston, and the water will follow it. This is owing to the same cause as the last: when the piston is pulled up, the air is drawn out of the syringe with it, and the pressure of the atmosphere is removed from the part of the water immediately under it; consequently, the water is obliged to yield in that part to the pressure on the surface. It is upon this principle that all those pumps called sucking pumps act: the piston fitting tightly the inside of the barrel, by being raised up, removes the pressure of the atmosphere from that part, and consequently the water is drawn up by the pressure upon the surface. See HYDRAULICS, and PUMP.

The effects arising from the weight and pressure of the atmosphere have been absurdly attributed to suction; a word which ought to be exploded, as it conveys a false notion of the cause of these and similar phenomena. To prove that an exhausted receiver is held down by the pressure of the atmosphere, take one, open at top, and ground quite flat, as A, (fig. 6), and covered with a brass plate, B, which has a brass rod passing through it, working in a collar of leather, so as to be air tight; to this rod suspend a small receiver within the large one, a little way from the bottom; place the receiver, A, upon the pump-plate, and exhaust it: it will now be fixed fast down; but the small receiver may be pulled up or down with perfect ease, as it is itself exhausted, and all the air which surrounded it removed, consequently it cannot be exposed to any pressure; let, then, the small one down upon the plate, but not over the hole by which the air is extracted, and readmit the air into the large receiver, which may then be removed; it will be found, that the small one being itself exhausted, is held down fast by the air, which is now admitted round the outside. If the large receiver be again put over it and exhausted, the small one will be at liberty, and so on, as often as the experiment is repeated. This effect cannot be accounted for upon any other principle than the pressure of the air; as the common idea of suction can have nothing to do in the case of the small receiver, which is fixed down merely by letting in the air round it. We ought, therefore, to attribute all those effects which are vulgarly ascribed to suction, such as the raising of water by pumps, &c. to the weight and pressure of the atmosphere.

A square column of quicksilver, $29\frac{1}{2}$ inches high, and an inch thick, weighs just 15 pounds, consequently, the air presses with a weight equal to 15 pounds, upon every square inch of the Earth's surface; and 144 times as much, or 2,160 pounds, upon every square foot. The Earth's surface contains, in round numbers, 200,000,000 square miles; and as every square mile contains 27,876,400 square feet, there must be 5,575,080,000,000,000 square feet on the Earth's surface; which number, multiplied

by 2,160 pounds (the pressure on each square foot), gives 12,043,468,800,000,000,000 pounds for the pressure, or whole weight of the atmosphere.

If the top of a small receiver be covered by a piece of flat, thin glass, upon exhausting it, the glass will be broke to pieces by the incumbent weight; and this would happen to the large receiver itself, but for the arched top, that resists the weight much more than a flat surface.

This experiment may be varied, by tying a piece of wet bladder over the open mouth of the receiver, and leaving it to dry till it becomes as tight as a drum. Upon exhausting the receiver, you will perceive the bladder rendered concave, and it will yield more and more, until it break with a loud report, which is occasioned by the air striking forcibly against the inside of the receiver, upon being re-admitted. Air, as we have seen, is one of the most elastic bodies in nature; that is, it is easily compressed into less compass, and when the pressure is removed it immediately regains its former bulk.

As all the parts of the atmosphere gravitate, or press upon each other, it is easy to conceive, that the air next the surface of the earth is more compressed and denser than what is at some height above it; in the same manner as if wool were thrown into a deep pit until it reached the top. The wool at the bottom having all the weight of what was above it, would be squeezed into a less compass; the layer, or stratum above it, would not be pressed quite so much; the one above that still less, and so on, till the upper one, having no weight over it, would be in its natural state. This is the case with the air, or atmosphere, that surrounds our earth, and accompanies it in its motion round the sun. On the tops of lofty buildings, but still more on those of mountains, the air is found to be considerably less dense than at the level of the sea. The height of the atmosphere has never yet been exactly ascertained; indeed, on account of its great elasticity, it may extend to an immense distance, becoming, however, rarer, in proportion to its distance from the earth. It is observed, that at a greater height than forty-five miles it does not refract the rays of light from the sun; and this is usually considered as the limit of the atmosphere. In a rarer state, however, it may extend much further. And this is by some thought to be the case, from the appearance of certain meteors which have been reckoned to be seventy or eighty miles distant, and whose light is thought to depend upon their coming through our atmosphere. Dr. Cotes has demonstrated, that if altitudes in the air be taken in arithmetical proportion, the rarity of the air will be in geometrical proportion. And hence it is easy to prove by calculation, that a cubic inch of such air as we breathe, would be so much rarefied at the altitude of 500 miles, that it would fill a sphere equal in diameter to the orbit of Saturn.

The elastic power of the air is always equivalent to the force which compresses it, for if it were less, it would yield to the pressure, and be more compressed; were it greater, it would not be so much reduced; for action and re-action are always equal, so that the elastic force of any small portion of the air we breathe, is equal to the weight of the incumbent part of the atmosphere; that weight being the force which confines it to the dimensions it possesses.

To prove this by an experiment, pour some quicksilver into the small bottle, A, (fig. 7), and screw the brass collar, C, of the tube, B C, into the brass neck of the bottle, and the lower end of the tube will be immersed into the quicksilver, so that the air above the quicksilver in the bottle will be confined there. This tube is open at top, and is covered by the receiver, G, and large tube, E F; which tube is fixed by brass collars to the receiver, and is closed at top. This preparation being made, exhaust the air out of the receiver, G, and its tube, by putting it upon the plate of the air-pump, and the air will, by the same means, be exhausted out of the inner tube, B C, through its open top at C. As the receiver and tubes are exhausting, the air that is confined in the glass bottle, A, will press so by its spring, as to raise the quicksilver in the inner tube to the same height as it stands in the barometer.

There is a little machine, consisting of two vanes of equal weights, independent of each other, and turn equally free on their axles in the frame. Each vane has four thin arms or sails fixed into the axis: those of the one have their planes at right angles to its axis, and those of the other have their planes parallel to it. Therefore, as the former turns round in common air, it is but little resisted thereby, because its sails cut the air with their thin edges; but the latter is much resisted, because the broad

side of its sails move against the air when it turns round. In each axle is a fine pin near the middle of the frame, which goes quite through the axle, and stands out a little on each side of it: under these pins a slider may be may be made to bear, and so hinder the vanes from going, when a strong spring is set or bent against the opposite ends of the pins.

Having set this machine upon the pump-plate, draw up a slider, and set the spring at bend on the opposite ends of the pins: then push down the slider, and the spring, acting equally strong upon each mill, will set them both a-going with equal forces and velocities; but the first will run much longer than the last, because the air makes much less resistance against the edges of its sails than against the sides of the other.

Draw up the slider again, and set the spring upon the pins as before; then cover the machine with the receiver upon the pump-plate; and having exhausted the receiver of air, push down the wire (through the collar of leathers in the neck) upon the slider; which will disengage it from the pins, and allow the vanes to turn round by the impulse of the spring: and as there is no air in the receiver to make any sensible resistance against them, they will both move a considerable time longer than they did in the open air; and the moment that one stops, the other will do so too. This shows that air resists bodies in motion, and that equal bodies meet with different degrees of resistance, according as they present greater or less surfaces to the air.

Take a tall receiver, covered at top by a brass plate, through which works a rod in a collar of leathers, and to the bottom of which there is a particular contrivance for supporting a guinea and a feather, and for letting them drop at the same instant. If they are let fall while the receiver is full of air, the guinea will fall much quicker than the feather; but if the receiver be first exhausted; it will be found that they both arrive at the bottom at the same instant, which proves that all bodies would fall to the ground with the same velocity, if it were not for the resistance of the air, which impedes most the motion of those bodies that have the least momentum. In this experiment the observers ought not to look at the top, but at the bottom of the receiver, otherwise, on account of the quickness of their motion, they will not be able to see whether the guinea and feather fall at the same instant.

Take a receiver, having a brass cap fitted to the top with a hole in it; fit one end of a dry hazel branch, about an inch long, tight into the hole, and the other end tight into a hole quite through the bottom of a small wooden cup; then pour some quicksilver into the cup, and exhaust the receiver of air, and the pressure of the outward air on the surface of the quicksilver will force it through the pores of the hazel, from whence it will descend in a beautiful shower, into a glass cup placed under the receiver to catch it.

Join the two brass hemispherical cups, A and B, together, (fig. 8) with a wet leather between them, having a hole in the middle of it; then having screwed off the handle at C, screw both the hemispheres put together into the pump-plate, and turn the cock E, so that the pipe may be open all the way into the cavity of the hemispheres; then exhaust the air out of them, and turn the cock; unscrew the hemispheres from the pump, and having put on the handle C, let two strong men try to pull the hemispheres asunder by the rings, which they will find hard to do; for if the diameter of the hemispheres be four inches, they will be pressed together by the external air with a force equal to 190 pounds; and to show that it is the pressure of the air that keeps them together, hang them by either of the rings upon the hook of a wire in the receiver of the air-pump, and, upon exhausting the air out of the receiver, they will fall asunder of themselves.

Set a square phial upon the pump-plate, and having covered it with a wire cage, put a close receiver over it, and exhaust the air out of the receiver; in doing which, the air will also make its way out of the phial, through a small valve in its neck. When the air is exhausted, turn the cock below the plate to re-admit the air into the receiver; and as it cannot get into the phial again, because of the valve, the phial will be broken into some thousands of pieces by the pressure of the air upon it. Had the phial been of a round form, it would have sustained this pressure, like an arch, without breaking; but as its sides are flat, it cannot.

Let a large piece of cork be suspended by a thread at one end of a balance, and counterpoised by a leaden weight, suspended in the same manner, at the other. Let this balance be hung to the inside of the top of a large receiver; which being set on the pump, and the air exhausted, the cork

will preponderate, and show itself to be heavier than the lead; but upon letting in the air again, the equilibrium will be restored. The reason of this is, that since the air is a fluid, and all bodies lose as much of their absolute weight in it as is equal to the weight of their bulk of the fluid, the cork, being the larger body, loses more of its real weight than the lead does; and therefore must in fact be heavier, to balance it under the disadvantage of losing some of its weight, which disadvantage being taken off by removing the air, the bodies then gravitate according to their real quantities of matter, and the cork, which balanced the lead in air, shews itself to be heavier when in vacuo.

Set a lighted candle upon the pump, and cover it with a tall receiver. If the receiver holds a gallon, the candle will burn a minute; and then, after having gradually decayed from the first instant, it will go out; which shows that a constant supply of fresh air is as necessary to feed flame, as animal life.

The moment when the candle goes out, the smoke will be seen to ascend to the top of the receiver, and there it will form a sort of cloud; but upon exhausting the air, the smoke will fall down to the bottom of the receiver, and leave it as clear at the top as it was before it was set upon the pump. This shows that smoke does not ascend on account of its being positively light, but because it is lighter than air; and its falling to the bottom when the air is taken away, shows that it is not destitute of weight. So most sorts of wood ascend or swim in water; and yet there are none who doubt of the wood's having gravity or weight.

Set a receiver which is open at top, on the air-pump, and cover it with a brass plate and wet leather; and having exhausted it of air, let the air in again at top through an iron pipe, making it pass through a charcoal flame at the end of the pipe; and when the receiver is full of that air, lift up the cover, and let down a mouse or bird into the receiver, and the burnt air will immediately kill it. If a candle be let down into that air, it will go out directly; but by letting it down gently, it will drive out the impure air, and good air will get in.

Set a bell on the pump-plate, having a contrivance so as to ring it at pleasure, and cover it with a receiver; then make the clapper strike against the bell, and the sound will be very well heard; but, exhaust the receiver of air, and then, if the clapper be made to strike ever so hard against the bell, it will make no sound; which shows that air is absolutely necessary for the propagation of sound.

It has been shown that air can be rarefied, or made to expand: we now proceed to show that it can also be condensed, or pressed into less space than what it generally occupies. The instrument used for this purpose is called a condenser: (fig. 9) represents a machine of this kind; it consists of a brass barrel containing a piston, which has a valve opening downwards; so that as the piston is raised, the air passes through the valve; but as the piston is pushed down the air cannot return, and is therefore forced through a valve at the bottom of the barrel, that allows it to pass through into the receiver, B, but prevents it from returning. Thus, at every stroke of the piston, more air is thrown into the receiver, which is of very thick and strong glass. The receiver is held down upon the plate, C, by the cross piece, D, and the screws E F. The air is let out of the receiver by the cock, G, which communicates with it.

The sound of a bell is much louder in condensed than in common air. A phial that would bear the pressure of the common atmosphere, when the air is exhausted from the inside, will be broken by condensing the air round it. These experiments may be made under the receiver B.

A very beautiful fountain may be made by condensed air. Procure a strong copper vessel, (fig. 10) having a tube that screws into the neck of it, so as to be air-tight, and long enough to reach near to the bottom. Having poured a quantity of water into the vessel, but not enough to fill it, and screwed in the tube, adapt to it a condensing syringe, and condense the air in the vessel; shut the stop-cock, and unscrew the syringe, then, on opening the stop-cock, the air acting upon the water in the vessel, will force it out into a jet of very great height. A number of different kinds of jets may be screwed on the tube, such as stars, wheels, &c. forming a very pleasing appearance.

The air-gun is a pneumatical instrument of an ingenious contrivance, which will drive a bullet with great violence, by means of condensed air, forced into an iron ball by a condenser. Fig. 11. represents the condenser for forcing the air into the ball. At the end of this instrument is a male

screw, on which the hollow ball, *b*, is screwed, in order to be filled with condensed air. In the inside of this ball is a valve, to hinder the air after it is injected from making its escape, until it be forced open by a pin, against which the hammer of the lock strikes; which then lets out as much air as will drive a ball with considerable force to a great distance.

When you condense the air in the ball, place your feet on the iron cross, *h h*, to which the piston-rod, *d*, is fixed; then lift off the barrel, *e a*, by the handles, *i i*, until the end of the piston is brought between *e* and *c*; the barrel, *a c*, will then be filled with air through the hole, *e*. Then thrust down the barrel, *ac*, by the handles, *i i*, until the piston, *e*, join with the neck of the iron ball at *a*; the air being thus condensed between *e* and *a* will force open the valve in the ball, and when the handles are lifted up again the valve will close and keep in the air, in this manner the ball will presently be filled; after which, unscrew the ball off the condenser, and screw it upon another male screw, which is connected with the barrel, and goes through the stock of the gun, as represented (fig. 12). The whole will be better understood by (fig. 13) which is a section of the gun. The inside, *k*, is that from which the bullets are shot, and, C D S R, is a larger barrel. In the stock of the gun, M, which forces the air through the valve, E P, into the cavity between the two barrels. There is a valve at S L, which being opened by the trigger, O, permits the air to rush suddenly behind the bullet, so as to drive it out with great force. If the valve is suddenly opened and closed, one charge of condensed air may make several discharges of bullets.

PNEUMORA, in natural history, a genus of insects of the order Hemiptera. Body ovate, inflated, diaphanous; head inflected, armed with jaws; thorax convex, carinate beneath; wing-cases deflected, membranaceous; legs formed for running. There are only three species, *viz.* 1. P. immaculata: green-spotted with white; wing-cases immaculate. 2. P. maculata: wing-cases green, with square white spots. And, 3. P. guttata: wing-cases green, with two white spots; abdomen with three white spots on each side. They are all found at the Cape of Good Hope. The insects of this genus appear to consist of a mere hollow inflated membrane: by rubbing together their serrate, or toothed legs, they make a shrill kind of noise morning and evening, and follow a light; and they are so nearly allied to the cricket tribe, that they have been enumerated by some naturalists under the genus Gryllus.

POA, in botany, *meadow-grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, or Grasses. Essential character: calyx two-valved, many-flowered; spikelet ovate; valves scariose at the edge, and sharpish. There are seventy-one species.

POCKET, in the woollen trade, a word used to denote a large sort of bag in which wool is packed up to be sent from one part of the kingdom to another. The pocket contains usually twenty-five hundred weight of wool.

PODOPHYLLUM, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Rhœadeæ. Ranunculaceæ, Jussieu. Essential character: calyx three-leaved; corolla nine-petalled; berry one-celled, crowned with the stigma. There are two species, *viz.* P. peltatum, duck's-foot, or May-apple; and P. diphyllum.

PODURA, in natural history, *spring-tail*, a genus of insects of the order Aptera. Generic character: lip bifid; four feelers, subclavate; two eyes, composed of eight facets; antennæ filiform; body scaly; tail forked, bent under the body, and acting as a spring, hence its name; six legs, formed for running. There are thirty-one species. They feed on leaves of various plants: the larva and pupa are six-footed, nimble, and resemble the perfect insect. P. aquatica is black, and, as its name imports, aquatic; they assemble in troops early in the morning, on the banks of pools and fish-ponds. P. ambulans is white, with a bifid extended tail, and is found principally among moss.

POETICAL *rising and setting of the stars.* The three kinds of rising and setting, *viz.* the cosmical, acronical, and heliacal, were made by the ancient poets, referring the rising, &c. of the stars to that of the sun.

POETRY. Dr. Blackwall, in his "Essay on the Life and Writings of Homer," says, on the subject of poetry, that "it is of a nature so delicate, as not to admit of a direct definition; for if ever the *je ne scais quoi* was rightly applied, it is to the powers of poetry, and the faculty that produces it. To go about to describe it would be like attempting to define inspiration, or that glow of fancy, or effusion of soul, which a poet feels while in his fit; a sensation so strong, that they express it only by adjur-

ings, exclamations, and rapture." To the same purpose, but in less inflated language, Dr. Blair has observed, that it is not so easy as might at first be imagined to ascertain with minute precision wherein poetry differs from prose. In point of fact, every reflecting reader must be sensible, that as it is difficult to determine the precise line where different shades of colour terminate, or even the boundaries of animal and vegetable nature, so it is a matter of no small nicety to fix the point where composition rises from the scale of prose to that of poetry.

By a small addition to the ideas of Aristotle, poetry may, however, be defined an imitative and creative art, whose energies are exerted by means of words metrically arranged, the end and design of which art is to amuse the fancy, and powerfully to excite the feelings.

It is the favourite expression of Aristotle, that poetry is a mimetic or imitative art; and in most particulars it may be justly so defined. The subjects of the poet's imitation are the scenes of nature, and the transactions of human life. This we shall find to be the case, if we particularly examine the productions of those to whom the concurrent voice of ages has given the title of poet. When we open the Iliad of Homer, we behold a lively representation of the actions and speeches of heroes and chiefs. The dramas of Æschylus, of Sophocles, of Aristophanes, and of their numerous tribes of successors, are nothing more than imitations of human manners. And when the lover displays his passion in song, what does he but exhibit to view the tablet of his heart, where we may trace his feelings, and view him agitated by doubt or exulting in hope. The chief interest of didactic poetry consists in the vivid and picturesque descriptions, the imitations or representations of nature, which relieve the insipidity of unornamented precept. This is manifest, when it is recollected, that the pleasure excited by the Georgic of Virgil is not occasioned by his agricultural instructions, but by his descriptions of the various phenomena which in the course of rural occupations arrest the attention of the lover of nature.

The word poet, in its original import, signifies creator. And as names are not unfrequently significant of the nature of the ideas which they represent, the name itself of poetry will direct us to one of its most distinguishing characteristics. It is indeed one of the noblest qualities of poetry, that it opens to the mind a new creation.

"The poet's eye, in a fine frenzy rolling,
Doth glance from heaven to earth, from earth to heaven;
And as imagination bodies forth
The form of things unknown, the poet's pen
Turns them to shapes, and gives to airy nothing
A local habitation and a name."

The poet enjoys the privilege of ranging through the boundless field of possibilities, and of selecting his objects according to the impulse of his fancy, as controuled and corrected by the discretion of his judgment. What is striking and interesting he may make prominent in his picture; what is offensive, deformed, or gross, he is at liberty to conceal or to soften. In the realities of life a thousand circumstances intervene to check the enthusiastic interest which our hearts are disposed to take in any specific occurrence. These circumstances the poet has a prescriptive right to exclude from his representations. As all ideas of men are primitively derived from objects of sense, he cannot go beyond the materials which the station and the powers of man supply. But he can, by an endless combination of these materials, produce ideal beings and fancied situations, which interest us the more the better the powers of fiction to which they owe their birth are concealed from us. Like the favoured statuary of Greece, he is surrounded by naked beauties, from each of which he selects its peculiar excellency, and produces a whole, which, though strictly natural, surpasses the realities of nature.

The mathematician in his investigation of truth is confined to the narrow path of reason. The same may be said of the philosopher. The slightest deviation into the fields of imagination frustrates their pursuit, and disappoints their hopes of fame. The historian must found his reputation upon a patient investigation of facts, and beware of giving the loosened rein to his inventive talents. The orator, indeed, calls fancy to the aid of reason; but she ought to be strictly an auxiliary. If his edifice be not founded on the solid basis of reason it will fall, together with its embellishments, to the ground. In oratory, fancy embellishes the operations of judgment; but so far as poetry is a creative art, imagination is its primary cause, and judgment a secondary agent,

employed to prune the luxuriant shoots of fancy.

It is the grand source of the excellence of poetic imitation, that this imitation is effected by words. Aristotle has defined words as "sounds significant:" they are significant of ideas. Men that adopt the same language, by a tacit compact, agree that certain sounds shall be the representatives of certain ideas. But ideas represent their archetypes. When, therefore, we use words, we revive in the minds of those who understand our language the pictures of the objects of which we speak. The poetic imitation then being carried on by means of words, evidently embraces all objects of which mankind have ever formed ideas. Its energies are not crippled. It expatiates in the universe, and even passes

—"the flaming bounds of space and time."

This circumstance is justly noted by the ingenious Mr. Harris, as bestowing upon poetry a decisive superiority over the art of painting. The energies of painting are confined to those objects that can be represented by colour and figure. Poetry can also express these objects, though it must be confessed, with a far inferior degree of exquisiteness; but this deficiency is amply compensated by the extensive range of the poet's excursions. He dives into the human heart, developes the windings of the heart, pourtrays in all their circumstances the workings of the passions, gives form and body to the most abstract ideas, and by the language which he puts into the mouths of his characters he unlocks the secrets of their mind. There is another grand advantage which the poet possesses over the painter, namely, that the latter is confined to the transactions that happen in a moment of time; while the former presents to our view a long series of consecutive events. An interesting picture might no doubt be drawn of the pious agony with which Æneas witnessed the obstinacy of his father in refusing to save himself from the sword of the Greeks by quitting his ancient and long-loved abode. But what a varied pleasure do we experience in reading of the circumstances that preceded and that followed this event, in tracing the steps of the duteous son from the palace of Priam to his father's mansion, and in beholding him at length bearing his parent beyond the reach of the foe. Aristotle's doctrine, that a finished composition should have a beginning, a middle, and an end, is founded on reason; and the mind feels a superior degree of satisfaction, when the rise, the circumstances, and the consequences of events are displayed before it in artful order.

But the poetic imitation or representation is effected, not merely by words, but by words metrically, or at least melodiously arranged.

Melody is naturally pleasing to the human ear; and it is not surprizing, that the cultivators of an art, whose province it is to delight, should be careful in bringing as nearly as possible to perfection the melody of their numbers. It is astonishing with what accuracy the Greeks and Romans attended to this particular; how minutely they weighed the value of almost every syllable; how strictly their bards were obliged to conform to the established standard. In modern times, and in our own language, greater latitude is allowed; yet almost every reader of poetry is aware of the charms of melodious composition. What a sensible difference do we perceive between the careless couplets of Churchill and the polished numbers of Pope. How much more pleasing to the ear are the measured sentences of M'Pherson, than a host of lines which we sometimes find printed in the form of verses.

But though melodious and metrical arrangement of words be one of the characteristics, and, as Dr. Blair denominates it, "the exterior distinction" of poetry, it is necessary to observe, that too many writers seem to assign to this characteristic a place of eminence to which it is by no means entitled. In consequence of this error, vast multitudes of compositions are obtruded upon the world under the name of poems, which possess no other merit than that of regularity of versification and smoothness of numbers. Against these wearisome productions Horace has long ago protested in his memorable declaration, that the quality of mediocrity is denied to poets, and that poetry includes something more in its definition than the measuring of syllables and the tagging of a verse. If the heart does not glow with the flame of genius, the mechanism of art will be of no avail. No one can excite strong feelings in others who is not himself strongly excited; no one can raise vivid images in the mind of his reader who is not himself illumined by the sportive light of fancy. Verses strictly and legitimately measured out, with due attention to pause

and cadence, but devoid of the animating spirit which characterizes true poetry, are, like the human body when deprived of the principle of life, cold, cheerless, and offensive.

He who aspires after the title of poet should never, indeed, forget, that the end of poetry is to amuse the fancy and powerfully to excite the feelings, and that this is effected by impressing the mind with the most vivid pictures. In the course of her operations, poetry hurries us beyond the reach of sober judgment, and captivates by rousing the energy of passion. Here then we see the cause of the power of verse, nor wonder at the efficaciousness which has, more especially in early times, been ascribed to the muses. For how easily are mankind guided by those who possess the art of awakening or of allaying their feelings. Though all unconscious of being under the guidance of another, they turn obedient to the rein. They are roused to insurrection, or moderated to peace, by him who can touch with a skilful hand the master springs that regulate the motions of their minds. "The primary aim of a poet," says Dr. Blair, "is to please and to move; and therefore it is to the imagination and the passions that he speaks. He may, and he ought to have it in his view, to instruct and to reform; but it is indirectly, and by pleasing and moving that he accomplishes this end. His mind is supposed to be animated by some interesting object, which fires his imagination, or engages his passions; and which of course communicates to his style a peculiar elevation, suited to his ideas, very different from that mode of expression which is natural to the mind in its calm ordinary state."

As then it appears to be the leading end of poetry to make a lively impression on the feelings, we may judge as it were *à priori* of the amazing intenseness of its powers, and we shall find our judgment verified when we come to inquire into the fact. In consequence of the efficacy of poetry upon the human feelings, the maxims of early wisdom, the first records of history, the solemn offices of religion, nay even the dictates of law, were delivered in the poetic dress. In the infancy of states, poetry is a method equally captivating and powerful of forming the dispositions of the people, and kindling in their hearts that love of glory which is their country's safeguard in the day of peril. Whether we look to the cold regions of Scandinavia, or the delicious clime of Greece; whether we contemplate the North American Indian, or the wild Arab of the desart; we find that when mankind have made a certain progress in society they are strongly influenced by a love of song, and listen with raptured attention to the strains that record the tale of other times, and the deeds of heroes of old. They listen till they imbibe the enthusiasm of warfare, and in the day of battle the hero's arm has not unfrequently been nerved by the rough energy of the early bard. It is a well-known fact, that the Greeks were accustomed to march to the fight while singing in praise of Apollo, and that the songs written in honour of Harmodius and Aristogiton, by being habitually recited at their banquets and solemn festivals, tended in no inconsiderable degree to preserve among the Athenians an enthusiastic love of liberty. Nor is the power of the muses done away by the progress of civilization. Every nation, at every period of its existence, possesses some indigenous poetry, which nourishes the flame of patriotism.

Such is the wonderful influence of poetical composition. Like all other powerful instruments, it may be, and it has been abused. But when directed to worthy objects, it is one of the most pleasant and most efficacious means of forming the youthful mind, and of exciting the emotions and enforcing the principles of virtue.

POHLIA, in botany, a genus of the Cryptogamia Musci class and order. Generic character: capsule ovate, oblong, placed on an obconical, narrower apophysis; peristome double; outer with sixteen broadish teeth; inner with a sixteen parted membrane. Males gemmaceous, on a distinct plant.

POINT, in geometry, as defined by Euclid, is a quantity which has no parts, or which is indivisible. Points are the ends or extremities of lines. If a point be supposed to be moved any way, it will, by its motion, describe a line. See LINE.

POINT, in physics, the least sensible object of sight, marked with a pen, point of a compass, or the like. Of such points all physical magnitude consists. This physical point is the same with what Mr. Locke calls the point sensible, and which he defines to be the least particle of matter, or space, we can discern. He adds, that to the sharpest eye, this is seldom less than thirty seconds of a circle, whereof the eye is the centre.

POINT, in grammar, a character used to mark the divisions of discourse. A point

proper is that which we otherwise call a full stop or period. See PUNCTUATION.

POINT, in astronomy, a term applied to certain points or places, marked in the heavens, and distinguished by proper epithets. The four grand points or divisions of the horizon, viz. the east, west, north, and south, are called the cardinal points. The zenith and nadir are the vertical points; the points wherein the orbits of the planets cut the plane of the ecliptic are called the nodes: the points wherein the equator and ecliptic intersect are called the equinoctial points; particularly, that whence the sun ascends towards the north pole, is called the vernal point; and that by which he descends to the south pole, the autumnal point. The points of the ecliptic, where the sun's ascent above the equator, and descent below it, terminate, are called the solsticial point; particularly the former of them, the estival or summer point; the latter, the brumal or winter point.

POINT *of the horizon*, or *compass*, in navigation and geography.

POINT is also used for a cape or headland, jutting out into the sea: thus, seamen say, two points of land are in one another, when they are so in a right line against each other, as that the innermost is hindered from being seen by the outermost.

POINT, in perspective, is used for various parts or places, with regard to the perspective plane. See PERSPECTIVE.

POINTS, in heraldry, are the several different parts of an escutcheon, denoting the local positions of any figure. There are nine principal points in an escutcheon: the dexter chief; the precise middle chief; the sinister chief; the honour-point; the fess-point, called also the centre; the nombril-point, that is, the navel-point; the dexter base; the sinister base; the precise middle base.

POINT is also used in heraldry for the lowest part of the escutcheon, which usually terminates in a point.

POINT is also an iron or steel instrument, used with some variety in several arts. Engravers, etchers, cutters in wood, &c. use points to trace their designs on the copper, wood, stone, &c. See ENGRAVING.

POINT, in the manufactories, is a general term used for all kinds of laces, wrought with the needle; such are the point de Venice, point de France, point de Genoa, &c. which are distinguished by the particular economy and arrangement of their points. Point is sometimes used for lace woven with bobbins, as English point, point de Malines, point d'Havre, &c.

POINT *of view*, with regard to building, painting, &c. is a point at a certain distance from a building or other object, in which the eye has the most advantageous view of the same. This point is usually at a distance equal to the height of the building.

POINT *blank*, in gunnery, is the horizontal position of a gun. The point blank range is the distance the shot goes before it strikes the level ground, when discharged in the horizontal or point blank direction. See GUNNERY.

POINTED, in heraldry. A cross pointed, is that which has the extremities turned off into points by straight lines.

POINTING, in grammar, the art of dividing a discourse, by points, into periods, and members of periods, in order to show the proper pauses to be made in reading, and to facilitate the pronunciation and understanding thereof. See PUNCTUATION.

POINTING, in war, the levelling a cannon or mortar, so as to play against any certain point. See GUNNERY, &c.

POINTING *the cable*, in the sea language, is untwisting it at the end, lessening the yarn, twisting it again, and making all fast with a piece of marline, to keep it from ravelling out.

POISONS, those substances which when applied externally, or taken into the human body, uniformly cause such a derangement of the animal economy as to produce disease. As it is extremely difficult, however, to give a definition of a poison, the above is subject to great inaccuracy. Poisons are divided, with respect to the kingdom to which they belong, into animal, vegetable, mineral, and vaporous poisons. Poisons are only deleterious in certain doses; for the most active, in small does, form very valuable medicines. There are, nevertheless, certain poisons which are really such in the smallest quantity, and which are never administered medicinally, as many of the animal poisons, the poison of hydrophobia, &c. There are likewise substances which are innocent when taken into the stomach, but which prove deleterious when taken into the lungs, or when applied to an abraded surface. Thus carbonic acid gas is continually swallowed with fermented liquors, and thus the poison of the viper may be swallowed with impunity; whilst inspiring carbonic acid instantly destroys, and the poison of the viper inserted into

the flesh produces formidable effects. Many substances also act as poisons when applied either externally or internally, as arsenic, lead, &c. When a deleterious substance produces its effects, not only in mankind, but in all other animals, it is distinguished by the term common poison, as arsenic, caustic, alkali, &c. whilst that which is poisonous to man only, or to brute animals, and often to one genus only, is said to be a relative poison; thus, aloes is said to be poisonous to dogs and wolves; the phellandrium aquaticum kills horses, whilst oxen devour it greedily and with impunity. It appears then, that substances act as poisons only in regard to their dose, the part of the body they are applied to, and the subject on which their powers are exerted.

It is often of great importance to be able to discover, by certain chemical tests, copper and lead, particles of which frequently find their way into the stomach, either through inadvertencies, as by the employment of certain kitchen utensils made of these materials, or by fraud, as when acetate of lead (sugar of lead) is made use of to revive wines that have grown sour by long keeping. If copper be suspected in any liquor, its presence may be ascertained by adding to it a solution of pure ammonia, which will strike a beautiful blue colour. If the solution be very dilute, it may be concentrated by evaporation, and if it contain a great excess of acid, as in the liquor of pickles, so much alkali must be added as will be sufficient to saturate the acid.

Lead is affirmed by Dr. Lambe to exist in water that passes through leaden pipes, in such quantities as to be injurious to the human frame; this has, however, been much doubted; but it is well known that petty dealers in wine have occasionally recourse to the acetate of lead to revive bad wines. Lead may be discovered in water by adding to a portion of it, about half its bulk of water impregnated with sulphuretted hydrogen gas. If lead be present, it will be manifested by a dark brown, or blackish tinge. For discovering the presence of lead in wine, a test is employed, called, from the name of the inventor, Hahnemann's wine test. This is prepared by putting together into a small phial, sixteen grains of sulphuret of lime prepared in the dry way, and twenty grains of acidulous tartrite of potash (cream of tartar). The phial to be filled with water and well corked, and occasionally shaken for a few minutes. When the powder has subsided, decant the clear liquor, and preserve it, in a well stopped bottle for use. The test, when newly prepared, discovers lead by a dark coloured precipitate. Lead may be likewise discovered by adding to the wine a solution of the sulphate of soda, which will throw down a precipitate. If a large quantity of the acetate of lead has been taken, as by a child, inadvertently on account of its saccharine taste; an active emetic must first be given, and then the hydro sulphuret of potash, or of ammonia be taken, a solution of the common sulphuret will answer.

POLAR, in general, something relating to the poles of the world, or poles of the artificial globes: thus we meet with polar circles, polar dial, polar projection, &c.

POLARITY, the quality of a thing considered as having poles; but chiefly used in speaking of the magnet. See MAGNETISM.

POLE, in astronomy, one of the extremities of the axis, on which the sphere revolves. These two points, each ninety degrees distant from the equinoctial or equator, are by way of eminence called the poles of the world; and the extremities of the axis of the artificial globes, corresponding to these points in the heavens, are termed the poles thereof. See GLOBE.

POLE, in spherics, a point equally distant from every part of the circumference of a great circle of the sphere, as the centre is a plane figure; or it is a point of ninety degrees distant from the plane of a circle, and in a line, called the axis, passing perpendicularly through the centre. The zenith and nadir are the poles of the horizon; and the poles of the equator are the same with those of the sphere.

POLES *of the ecliptic*, are two points on the surface of the sphere, 23° 30′ distant from the poles of the world, and 90° distant from every part of the ecliptic.

POLES, in magnetics, are two points of a loadstone, corresponding to the poles of the world; the one pointing to the north, the other to the south. See MAGNETISM.

POLE, PERCH, or ROD, in surveying, is a measure containing sixteen feet and a half.

POLE, or POLAR *star*, is a star of the second magnitude, the last in the tail of ursa minor. Its longitude Mr. Flamsteed makes 24° 14′ 41″; its latitude, 66° 4′ 11″. The nearness of this star to the pole, whence it happens that it never sets, renders it of vast service in navigation, &c. for deter-

mining the meridian line, the elevation of the pole, and, consequently, the latitude of the place, &c. See LATITUDE.

POLEMONIUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Polemonia, Jussieu. There are five species, chiefly natives of the Cape of Good Hope.

POLEMOSCOPE, in optics, a kind of reflecting perspective glass invented by Hevelius, who commends it as useful in sieges, &c. for discovering what the enemy is doing, while the spectator lies hid behind an obstacle.

POLIANTHES, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Narcissi, Jussieu. Essential character: corolla funnel form, curved in, equal, filaments inserted into the jaws of the corolla; germ at the bottom of the corolla. There is but one species, viz. P. tuberosa, tuberose.

POLICY *of assurance*, is the deed or instrument by which a contract of assurance is effected. The premium paid for the risk must be inserted in the policy, and likewise the date. Policies for assurance against the risks of the sea are distinguished into valued and open policies; in the former the property is assured at prime cost, at the time of effecting the policy, in the latter, the value is not mentioned, but is left to be afterwards declared, or to be proved in the event of a claim.

POLISHER, or BURNISHER, among mechanics, an instrument for polishing and burnishing things proper to take a polish. The gilders use an iron-polisher to prepare their metals before gilding, and the blood-stone to give them the bright polish after gilding. The polisher used by the makers of spurs and bits, &c. is partly iron, partly steel, and partly wood; it consists of an iron-bar with a wooden handle at one end, and a hook at the other, to fasten it to another piece of wood held in the vice, while the operator is at work. In the middle of the bow, withinside, is what is properly called the polisher, being a triangular piece of steel with a tail, whereby it is riveted to the bow. The polishers, among cutlers, are a kind of wooden wheels made of walnut-tree, about an inch thick, and of a diameter at pleasure, which are turned round by the great wheel; upon these they smooth and polish their work with emery and putty. The polishers for glass consist of two pieces of wood; the one flat, covered with old hat, the other long and half-round, fastened on the former, whose edge it exceeds on both sides by some inches, which serve the workmen to take hold of, and to work backwards and forwards by. The polishers, used by spectacle-makers, are pieces of wood a foot long, seven or eight inches broad, and an inch and a half thick, covered with old beaver-hat, whereon they polish the shell and horn-frames their spectacle glasses are to be set in.

POLISHING, in general, the operation of giving a gloss or lustre to certain substances, as metals, glass, marble, &c.

POLITICAL *arithmetic* is the application of arithmetical calculation, to political subjects, as the public revenues, number of people, extent and value of lands, taxes, trade, manufactures, &c. of any commonwealth. See STATISTICS.

POLITY, or POLICY, denotes the peculiar form and constitution of the government of any state or nation; or, the laws, orders, and regulations relating thereto.

Polity differs only from politics, as the theory from the practice of any art. See LAW, GOVERNMENT, &c.

Some divide polity into that which relates to the regulations respecting mercantile affairs; and to those which concern the judiciary government of the citizens: some add other branches, viz. those relating to ecclesiastical and military affairs. &c.

POLL, a word used in ancient writings for the head: hence to poll, is either to vote or to enter down the names of those persons who give in their votes at an election.

POLL *money*, a capitation or tax imposed by the authority of parliament on the head or person either of all indifferently, or according to some known mark of distinction.

POLLEN, in botany, the fecundating or fertilizing dust contained within the anthers or tops of the stamina, and dispersed on the pistil when ripe, for the purpose of impregnation. This dust is commonly of a *yellow* colour, and is very conspicuous in the tulip and lily. If this powder is examined by the microscope, it will be found to assume some determinate form, which often predominates, not only through the different species of one genus, but through all the genera of an order. Being triturated in the stomach of bees, by whom great quantities are collected in the hairy brushes with

which their legs are covered, is supposed to produce the wax. See WAX.

POLLIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Junci, Jussieu. Essential character: corolla inferior, six-petalled; berry many-seeded. There is but one species, *viz.* P. japonica.

POLLICHIA, in botany, a genus of the Monandria Monogynia class and order. Natural order of Amaranthi, Jussieu. Essential character: calyx one-leafed, five-toothed; corolla five-petalled; seed solitary; receptacle producing succulent aggregate scales, sustaining the fruit. There is but one species, *viz.* P. campestris, whorled-leaved pollichia, a native of the Cape of Good Hope.

POLLUX, in astronomy, a fixed star of the second magnitude in the constellation gemini, or the twins. The same name is also given to the hindermost twin, or posterior part of the same constellation.

POLYADELPHIA, in botany, a class of plants, the eighteenth in order, whose stamina are connected together at their bases into several serieses. The plants of this class, are subdivided into orders according to the number of their stamina; thus the polyadelphia pentandria, contain five stamina; and the polyadelphia icosandria and polyandria, contain twenty or more stamina. There are but few genera included in this class. The chocolate-nut has five stamina, or rather five bundles of stamina; each filament has five anthers. Monsonia has fifteen stamina in five bundles. The citron, lemon, and orange, belonging to the genus citrus have twenty stamina in several bundles. The St. John's wort have many stamina collected into five bundles.

POLYANDRIA, in botany, a class of plants, the thirteenth in order, with hermaphrodite flowers, and a large number of stamina in each; those always exceed the number of twelve, and grow on the receptacle of the future seeds. By this circumstance chiefly, the class is distinguished from the ICOSANDRIA, which see. The most striking character is the situation of the stamina, which are inserted into the calyx or petals, or both. This is an unerring mark of distinction. This class is subdivided into seven orders from the number of the styles; the poppy, water-lily, &c. have one style; the peony, two; lark-spur, three; tetracera, four; columbine, five; water-soldier, six; virgin's bower, tulip-tree, &c. have many.

POLYCARDIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: petals five-rounded; stigma lobed; capsule five-celled, five-valved; seeds arilled. There is only one species, *viz.* P. madagascarensis, a native of Madagascar, where it was found by Commerson.

POLYCARPON, in botany, a genus of the Triandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals five, ovate, very small; capsule one-celled, three-valved; seeds very many. There is only one species, *viz.* P. tetraphyllum, four-leaved all-seed, a native of the South of Europe.

POLYCNEMUM, in botany, a genus of the Triandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx three-leaved; petals five, calycine; seed one, almost naked. There are five species.

POLYGALA, in botany, *milk-wort*, a genus of the Diadelphia Octandria class and order. Natural order of Lomentaceæ. Pediculares, Jussieu. Essential character: calyx five-leaved, with two of the leaves shaped like wings and coloured; legume obcordate, two-celled. There are forty-five species.

POLYGAMIA, in botany, a class of plants, the twenty-third in order, the characters of which are, that they have flowers of different structure; some having male flowers, others female ones, and others hermaphrodite.

A polygamous plant must have some of its flowers hermaphrodite. By this circumstance its connection is cut off with the plants of the classes monœcia, and diœcia, in the former of these the plants are androgenous, that is, bear male and female flowers on the same root; in the latter on different roots. 1. We have instances of hermaphrodite and male flowers on the same plant, in the white helebore, &c.; also in several of the umbelliferous plants as the carrot, coriander, chervil, &c. 2. Instances of hermaphrodite, and male flowers on distinct plants, may be given in the palmetto, ginseng, Indian date plum. 3. Hermaphrodite and female on the same plant, as in the pellitory and orack. 4. Hermaphrodite and female on different plants as in most species of the ash-tree.

POLYGAMY, a plurality of wives or

husbands, in the possession of one man or woman, at the same time.

POLYGLOTT, among divines and critics, chiefly denotes a Bible printed in several languages. In these editions of the Holy Scriptures, the text in each language is ranged in opposite columns. The first polyglott Bible, was that of Cardinal Ximenes, printed in 1517, which contains the Hebrew text, the Chaldee Paraphrase on the Pentateuch, the Greek version of the LXX., and the ancient Latin version. After this, there were many others, as the Bible of Justiniani, Bishop of Nebio, in Hebrew, Chaldee, Greek, Latin, and Arabic; the Psalter, by John Potken, in Hebrew, Greek, Ethiopic, and Latin; Plantin's Polyglott Bible, in Hebrew, Chaldee, Greek, and Latin, with the Syriac version of the New Testament; M. le Jay's Bible, in Hebrew, Samaritan, Chaldee, Greek, Syriac, Latin, and Arabic; Walton's Polyglott, which is a new edition of Le Jay's Polyglott, more correct, extensive, and perfect, with several new oriental versions, and a large collection of various readings, &c.

POLYGON, in geometry, a figure with many sides, or whose perimeter consists of more than four sides at least: such are the pentagon, hexagon, heptagon, &c.

Every polygon may be divided into as many triangles as it has sides; for if you assume a point, as *a*, (see Plate XII. Miscel. fig. 14), any where within the polygon, and from thence draw lines to every angle, *a b*, *a c*, *a d*, &c. they shall make as many triangles as the figure has sides. Thus, if the polygon hath six sides (as in the figure above) the double of that is twelve, from whence take four, and there remains eight: I say, that all the angles, *b*, *c*, *d*, *e*, *f*, *g*, of that polygon, taken together, are equal to eight right angles. For the polygon, having six sides, is divided into six triangles; and the three angles of each by 1.32 Eucl. are equal to two right ones; so that all the angles together make twelve right ones; but each of these triangles hath one angle in the point, *a*, and by it they complete the space round the same point; and all the angles about a point are known to be equal to four right ones, wherefore those four taken from twelve, leave eight, the sum of the right angles of the hexagon. So it is plain the figure hath twice as many right angles as it hath sides, except four.

Every polygon circumscribed about a circle, is equal to a rectangled-triangle, one of whose legs shall be the radius of the circle, and the other the perimeter (or sum of all the sides) of the polygon. Hence, every regular polygon is equal to a rectangled-triangle, one of whose legs is the perimeter of the polygon, and the other a perpendicular drawn from the centre to one of the sides of the polygon. And every polygon circumscribed about a circle is bigger than it; and every polygon inscribed is less than the circle, as is manifest, because the thing containing is always greater than the thing contained. The perimeter of every polygon circumscribed about a circle, is greater than the circumference of that circle, and the perimeter of every polygon inscribed is less. Hence, a circle is equal to a right-angled triangle, whose base is the circumference of the circle, and its height the radius of it.

For this triangle will be less than any polygon circumscribed, and greater than any inscribed; because the circumference of the circle, which is the base of the triangle, is greater than the compass of any inscribed, therefore it will be equal to the circle. For, if this triangle be greater than any thing that is less than the circle, and less than any thing that is greater than the circle, it follows, that it must be equal to the circle. This is called the quadrature or squaring of the circle; that is, to find a right-lined figure equal to a circle, upon a supposition that the basis given is equal to the circumference of the circle; but actually to find a right line equal to the circumference of a circle, is not yet discovered geometrically.

POLYGON, in fortification, denotes the figure of a town, or other fortress. The exterior or external polygon is bounded by lines drawn from the point of each bastion to the points of the adjacent bastions; and the interior polygon is formed by lines joining the centres of the bastions.

POLYGONS, *problems concerning*. 1. On a regular polygon to circumscribe a circle, or to circumscribe a regular polygon upon a circle: bisect two of the angles of the given polygon, A and B, (fig. 15), by the right lines, A F, B F; and on the point, F, where they meet, with the radius, A F, describe a circle, which will circumscribe the polygon. Next to circumscribe a polygon, divide 360 by the number of sides required, to find *e* F *d*; which set off from the centre, F, and draw the line, *d e*, on which construct the polygon as in the following problem. 2. On a given line to describe any given regular polygon: find the angle of the

polygon in the table, and in E set off an angle equal thereto; then drawing $EA = ED$ through the points, E, A, D, describe a circle, and in this applying the given right line as often as you can, the polygon will be described. 3. To find the sum of all the angles in any given regular polygon: multiply the number of sides by 180°; from the product subtract 360°, and the remainder is the sum required: thus, in a pentagon, $180 \times 5 = 900$, and $900 - 360 = 540$, the sum of all the angles in a pentagon. 4. To find the area of a regular polygon: multiply one side of the polygon by half the number of sides; and then multiply this product by a perpendicular, let fall from the centre of the circumscribing circle, and the product will be the area required: thus, if A B (the side of a pentagon) $= 54 \times 2\frac{1}{2} = 135$, and 135×29 (the perpendicular) $= 3915 =$ the area required. 5. To find the area of an irregular polygon, let it be resolved into triangles, and the sum of the areas of these will be the area of the polygon.

POLYGONAL *numbers*, are so called, because the units whereof they consist may be disposed in such a manner as to represent several regular polygons.

The side of a polygonal number is the number of terms of the arithmetical progression that compose it; and the number of angles is that which shows how many angles that figure has, whence the polygonal number takes its name.

"To find any polygonal number proposed;" having given its side, n, and angles, a. The polygonal number being evidently the sum of the arithmetical progression, whose number of terms is n, and common difference $a - 2$, and the sum of an arithmetical progression being equal to half the product of the extremes, by the number of terms, the extremes being 1, and $1 + d \cdot \overline{n-1} = 1 + \overline{a-2} \cdot \overline{n-1}$; therefore, that number, or this sum, will be

$$\frac{n^2 d - n \cdot \overline{d-2}}{2} \text{ or } \frac{n^2 \cdot \overline{a-2} - n \cdot \overline{a-4}}{2},$$

where d is the common difference of the arithmeticals that form the polygonal number, and is always 2 less than the number of angles, a.

Hence, for the several sorts of polygons, any particular number, whose side is n, will be found from either of these two formulæ, by using for d, its values 1, 2, 3, 4, &c.; which gives these following formulæ for the polygonal number in each sort, viz. the

Triangular.............. $\frac{n^2 + n}{2}$,

Square.................. $\frac{2n^2 - 0n}{2} = n^2$,

Pentagonal............. $\frac{3n^2 - n}{2}$,

Hexagonal.............. $\frac{4n^2 - 2n}{2}$,

Heptagonal............ $\frac{5n^2 - 3n}{2}$,

&c.

POLYGONUM, in botany, a genus of the Octandria Trigynia class and order. Natural order of Haloraceæ. Polygoneæ, Jussieu. Essential character: calyx none; corolla five-parted, calycine; seed one, angular. There are thirty-six species.

POLYGYNIA, among botanists, denotes an order or subdivision of a class of plants, comprehending such plants of that class, as have a great number of pistils, or female organs of generation.

POLYHEDRON, in geometry, denotes a body or solid comprehended under many sides, or planes. A gnomonic polyhedron is a stone with several faces, whereon are described various kinds of dials.

POLYHEDRON, *polyscope*, in optics, is a multiplying glass or lens, consisting of several plane surfaces disposed into a convex form.

POLYMNIA, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx exterior, four or five-leaved; interior ten-leaved; the leaflets concave; down none; receptacle chaffy. There are five species.

POLYNEMUS, the *polyneme*, in natural history, a genus of fishes of the order Abdominales. Generic character: head compressed, covered with scales; snout very obtuse and prominent; gill-membrane, five or seven-rayed; separate filaments near the base of the pectoral fins. Shaw enumerates ten species; Gmelin only four.

The P. paradiseus, or Paradise polyneme, or Mango-fish, inhabits the Indian and American seas, and is thirteen inches long, elegantly shaped, and with thoracic filaments frequently far larger than the body; its colour is yellow. At Calcutta it is in the highest estimation for the table.

P. plebeins, or the grey polyneme, abounds on the Malabar coast, and has five filaments on each side, but all rather short. It is sometimes four feet long, and is in

some parts of India denominated the royal fish, from its extraordinary excellence. The application of the epithets, royal and plebeian, to the same animal, constitutes a curious coincidence: the former probably refers to the plainness of its appearance, and the other to its exquisiteness for food.

P. niloticus, is both in form and taste superior to every other fish in the rivers which flow into the Mediterranean or Atlantic seas. It is covered with scales, resembling the most brilliant silver spangles, and is of the weight of thirty, in some instances, of seventy pounds. It is a native of the Nile, and Mr. Bruce has minutely detailed the process adopted by the Egyptians for taking it, by a cake of flour, dates, and other ingredients, with a considerable number of hooks concealed in it; but attached to a string held by the fisherman, who floats on the stream, upon a blown-up goat's skin, in order to sink this mass, and then returns to the bank. He then fixes the line to some tree, connecting it with a bell, the sounds of which give him notice of the success of his experiment, being produced by the twitchings and pulls of the fish.

POLYPE, or POLYPUS, in zoology, a small fresh-water insect of a cylindric figure, but variable, with very long tentacula. See HYDRA.

POLYPODIUM, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices, or Ferns. Generic character: capsules distributed in roundish dots, on the back or lower surface of the frond. There are one hundred and thirty-seven species; most of these are of American growth, and very little known in Europe, except from dried specimens, not always collected with judgment enough to show satisfactorily the true characters of the fronds and fructification.

POLYPREMIUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Caryophyllei. Scrophulariæ, Jussieu. Essential character: calyx four-leaved; corolla four-cleft; wheel-shaped, with obcordate lobes; capsule compressed, emarginate, two-celled. There is but one species, viz. P. procumbens, a native of Carolina and Virginia.

POLYTRICHUM, in botany, a genus of the Cryptogamia Musci class and order. Natural order of Musci or Mosses. Essential character: capsule lidded, on a very small apophysis or receptacle; capsule, villose. There are nineteen species, chiefly natives of the north-west coast of North America.

POMACEÆ, in botany, the name of the thirty-sixth order in Linnæus's Fragments of a Natural Method, consisting of genera, which have a pulpy esculent fruit, of the apple, berry, and cherry kind; such are the prunus, pyrus, ribes, &c. The plants of this order are most of the shrub and tree kind: the roots are branched, fibrous, and long. In the drop-wort they consist of a number of oval knobs, which hang, or are fastened together by slender fibres: hence, its English name, and also the Linnæan name spiræa filipendula. The stems and branches are cylindric; the bark is thick and wrinkled. The buds are of a conical form, placed in the angles of the leaves, and covered with scales which lie over one another like tiles. In the apple, pear, plum, &c. besides the buds of the leaves, there are scaly buds or eyes of a different form from which proceed bundles or clusters of flowers. The leaves which differ in form, being in some genera simple, in others winged, are, in the greater number placed alternate. The flowers are universally hermaphrodite, except in the spiræa aruncus, in which male and female flowers are produced upon distinct plants. The flower-cup is of one piece with five divisions which are permanent, and placed above the seed-bud, in the apple, currant, &c.; in others they fall off with the flower, or wither upon the stalk. The petals are five, inserted into the tube of the calyx. The stamina are generally twenty and upwards, attached also to the margin of the tube of the calyx, the anthers are short, and slightly attached to the filaments. The seed-bud is single; and the seed-vessel is a pulpy fruit of the apple, berry, or cherry-kind. Those of the apple kind are divided internally into a number of cells. The seeds in the pomegranate, apple, and currant-trees, are numerous; in the service-tree three; in the medlar five: in peach, plum, &c. a single nut or stone, containing a kernel.

POMETIA, in botany, a genus of the Monoecia Hexandria class and order. Essential character: calyx, one-leafed, six-cleft; petals six: male, stamens six: female, berry globular, with one seed in the centre. There are two species, viz. P. pinnata and P. ternata.

POMMEREULLIA, in botany, so named in memory of Lady du Gage de Pommereull, a genus of the Triandria Monogynia class and order. Natural order of Gra-

mina, or Grasses. Essential character: calyx, turbinate, two valved, three or four flowered; valves four cleft, awned at the back; corolla, two valved, awned. There is but one species, viz. P. cornucopiæ a native of the East Indies, whence it was found by Koenig.

POMUM, in botany, an *apple:* a species of seed-vessel composed of a succulent fleshy pulp, in the middle of which is generally found a membranous capsule, with a number of cavities for containing the seeds. Seed-vessels of this kind have no external opening or valve. At the end opposite to the foot stalk is frequently a small cavity, called by gardeners the eye of the fruit, and by botanists "umbilicus" from its fancied resemblance to the navel in animals.

PONÆA, in botany, so named in memory of John Pona, a genus of the Octandria Trigynia class and order. Natural order of Sapindi, Jussieu. Essential character: calyx five parted, spreading; petals four, with pilliferous glands at the tip; germ three-sided; capsule, three-winged, three-celled, with one seed in each cell. There is only one species, viz. P. guianensis.

PONTEDERIA, in botany, so named in memory of Julius Pontedera, professor of botany at Padua, a genus of the Hexandria Monogynia class and order. Natural order of Ensatæ. Narcissi, Jussieu. Essential character: corolla one petalled, six-cleft, two lipped; stamens, three inserted into the top, three into the tube of the corolla; capsule three-celled. There are seven species; these are aquatic herbaceous perennial plants, with fibrous roots, chiefly natives of the East Indies; both root and stem leaves sheathing, frequently sagittate; flowers in spikes or umbels terminating, or put forth from the cloven sheath of the leaves, each having a spathe.

PONTON, or PONTOON, in war, denotes a little floating bridge made of boats and planks. The ponton is a machine consisting of two vessels, at a little distance, joined by beams, with planks laid across for the passage of the cavalry, the cannon, infantry, &c. over a river, or an arm of the sea, &c. The late invented ponton is of copper furnished with an anchor, &c. to fix it. To make a bridge, several of these are disposed two yards asunder, with beams across them; and over those are put boards or planks. They are also linked to each other, and fastened on each side of the river by a rope run through a ring in each of their heads, and fixed to a tree or stake on either shore: the whole makes one firm uniform bridge, over which a train of artillery may pass.

POOP, the stern of a ship, or the highest, uppermost, and hinder part of the ship's hull.

POOR *laws.* Of the general outline of this most enormous and almost ineffectual burden on the people, much has been said in the excellent treatise of Mr. Colquhoun. The 43 of Elizabeth, c. 2, is the foundation of all that is good in the poor laws; making provision for finding work for the industrious and able; for compelling the idle and able to labour; and for affording relief to the diseased and impotent: and the 13, 14 Charles II. c. 12, is the foundation of all that is evil, by forming the system of settlements and removals; a system, establishing oppression, litigation, and expense, and which has been made more oppressive, and more productive of litigation and expense by every subsequent statute, till the statute of the 35th of his present Majesty; which, by forbidding removals in case the pauper is not absolutely chargeable, has remedied more than half the evils occasioned by the former laws.

Overseers. The churchwardens of every parish, with two, three, or four substantial householders, according to the size of the parish, to be nominated in Easter week, or within a month after, under the hands and seals of two or more neighbouring justices, and who shall be called overseers of the poor. 43 Elizabeth, c. 2, s. 1.

Where there are no churchwardens, the whole power is vested in the overseers, 17 George II. c. 38, s. 15.

Overseer dying, or becoming incapable of acting, two justices may appoint another. *Ibid.* s. 3. If any person shall find himself aggrieved by any act of the justices, Ap.* sessions, whose determination shall be final. *Ibid.* s. 6.

Where there is no nomination of overseers, P. 5*l.* on every justice of the division. R. by distress from the sessions, to be levied by the churchwardens and overseers. 43 Elizabeth, c. 2, s. 10.

Parish officers, with consent of two justices, shall set children to work, whose pa-

* In this article the following abbreviations will be used: P. denotes penalty; R. the mode of recovering it; A. the application; Ap. the appeal; J. 1 or 2, and W. 1 or 2, justices or witnesses.

rents cannot maintain them, and all persons, married or single, who cannot maintain themselves, and have no regular trade or calling; and one justice may send persons to the house of correction who will not work; and the parish officers, not having an excuse, to be allowed by two justices, shall meet once in a month, at least, in the church on a Sunday after evening service, to consult. P. 20*s*. R. distress, and, in default, commitment till paid. J. 2. A. the poor. Ap. sessions. *Ibid*. s. 1, 2, 6, 11.

Overseers, within four days after the end of their year, shall account to two justices of all sums received and paid, and pay over what remains to their successors; who, in default, may levy it by distress, under warrant of two justices; who, in default of distress, may commit till paid. *Ibid*. s. 2, 4.

Every parish officer neglecting to obey the regulations of the above act, P. 40*s*. to 5*l*. R. distress. J. 2. A. the poor. 17 George II. c. 38, s. 14.

Parish officer neglecting his duty, or disobeying the warrant of a justice, P. 40*s*. R. distress, and, in default, commitment not exceeding ten days. J. 2. A. the poor. Ap. sessions, giving ten days notice. 33 George III. c. 55, s. 1, 2.

Rate. Parish officers shall raise by a rate on all the inhabitants, a stock of flax, &c. to set the poor to work, and sums for the relief of the old and lame who are not able to work, and for apprenticing poor children. Rate to be made by consent of two justices. 43 Elizabeth c. 2, s. 1.

Parish officers shall cause notice to be given publicly in the church, of such consent of the justices, the next Sunday; and no rate shall be collected till such notice is given. 17 George II. c. 3, s. 1. They shall permit the inhabitants to inspect such rates at all seasonable hours, on payment of 1*s*.; and give copies on payment of 6*d*. for every twenty-four names. P. 20*s*. A. to to the party aggrieved. *Ibid*. s. 2, 3.

Persons aggrieved by assessment, Ap. sessions. 17 George II. c. 38, s. 4.

Goods of persons refusing to pay, may be distrained in any part of the county; and of any other county, on oath made before a justice of such other county, which oath shall be certified in the warrant. Ap. to the sessions of the county where the assessment was made. *Ibid*. s. 7.

If two justices perceive that the inhabitants of any parish are not able to levy money sufficient for the relief of the poor, they shall assess any neighbouring parishes within the hundred, in aid; and if the hundred shall not be of sufficient ability, then any parishes within the county. 43 Elizabeth, c. 2, s. 3.

Father, grandfather, mother, or grandmother, of persons wanting relief, shall maintain them; P. 20*s*. per month. R. distress, and, in default, commitment till paid. J. 2. A. the poor. *Ibid*. s. 2, 11.

Fathers leaving their wives and children, and mothers their children, chargeable to the parish, having ability to maintain them, the parish officers, where such are left, may, by warrant of two justices, seize so much of the goods and chattels, or receive so much of the annual rent as such justices shall appoint, to reimburse the parish; and such order to be confirmed by the sessions. 5 George I. c. 8. s. 1.

Parish officers, with consent of the lord of the manor, may, by order of two justices, erect cottages on waste lands, for the poor. 43 Elizabeth, c. 2, s. 5.

They may also, with consent of two justices, set up trades, &c. for the employment of the poor. 3 Charles II. c. 4, s. 22.

Relief. Parish officers, with consent of the majority of the inhabitants, may contract with any person for the lodging, keeping, maintaining, and employing the poor; and persons refusing such relief are not entitled to any other. 9 George I. c. 7, s. 4.

The abominable oppression of this execrable law has, however, been removed by another humane statute of the present reign; for by 36 George III. c. 25, s 1, 2, 3, it is enacted, that it shall be lawful for the parish officers, with the approbation of one justice in writing, to relieve any industrious person at his own habitation, under certain circumstances of temporary illness or distress; and one justice may order such relief for any time not exceeding one month, provided the cause be written on the back of the order, which the parish officers are bound to obey; and two justices may continue such order from time to time, each period in succession not being more than one month.

A justice, or a medical man, or clergyman, by warrant of a justice, may visit workhouses, and examine the state of them, and hear complaints, and certify to the sessions; and if there should be any infectious disorder, the visiting justice shall apply to another justice, or any other person visiting, to two justices; which two justices shall order such regulations as they deem neces-

sary, til the next sessions. 30 George III. c. 49, s. 1, 2.

Names of persons receiving parish relief to be entered in a book. 3 William, c. 11, s. 11. And no other person to be relieved but by order of a justice. *Ibid.*

No relief to be ordered by a justice unless for a reasonable cause, proved on oath, and unless the pauper shall have first applied to a parish officer or a vestry, nor before the justice shall have summoned the parish officers. 9 George I. c. 7, s. 1.

The name of such person to be entered with the others; and no parish officer, except on sudden emergency, shall bring any charge on the parish for persons not so registered. P. 5*l.* R. distress. J. 2. A. poor. *Ibid.* s. 2.

Persons receiving relief to be badged on the shoulder with a large Roman P, and the initial of the name of the parish. P. forfeiture of the relief, or commitment for not above twenty-one days. J. 1. And on every peace officer who shall relieve any person not so badged, 20*s.* R. distress. J. 1. A. half to the informer, half to the poor. 8, 9 William, c. 3. s. 2.

Settlements. The general heads on which settlements are founded are, birth, apprenticeship, service, serving offices, renting 10*l.* per annum, marriage, and estate.

1. *Birth.* Children, *primâ facie*, whether bastard or legitimate, are settled where born: but with respect to bastards, if a woman goes collusively to be delivered in another parish, the child gains no settlement there.

Bastards born during an order of removal, or the suspension of it, belong to the mother's parish. 35 George III. c. 101, s. 6. And so of bastards born in vagrancy. 17 George II. c. 5, s. 25. And so if born in houses of industry in incorporated districts. 20 George III. c. 36. Or in friendly societies. 33 George III. c. 54, s. 25. Or in lying-in hospitals. 13 George III. c. 82.

Legitimate children are settled as their parents, till old enough to gain a settlement of their own; the earliest period of which is seven years: at which age, by 5 Elizabeth, c. 5, s. 12, a child may be apprenticed to a person using the seas; and by 17 George II. c. 5, justices may bind the child of a vagrant of the same age; and any apprentice gains a settlement in a place where he has resided as such for forty days.

2. *Apprenticeship.* The time required to gain a settlement has just been mentioned. The apprentice must be legally bound, except that the contract not being indented, which is fatal to the legality in every other case, is not in this. 31 George II. c. 11.

3. *Service.* Unmarried person without children, hired and serving for a year, gains a settlement. 3 William, c. 11. But must continue a whole year in such service. 8, 9 William, c. 30. Serving a certificated member of a benefit society no settlement. 33 George III. c. 54, s. 24. Forty days residence in the place necessary, but they need not be all together. Where the last forty days are in different places, settlement where the servant slept the last night. General hiring deemed hiring for a year. Hiring for a year, with liberty to be absent at harvest, sheep-shearing, &c. gains no settlement; but to serve a month in the militia does. Hiring for one day short of a year no settlement. Serving for three hundred and sixty-five days, if leap year, no settlement. Hiring at so much per week, conditionally to part at a month's warning, deemed a general hiring; and, as such, a hiring for a year.

4. *Serving Offices.* Persons coming to inhabit a place, and executing any annual and public office for a year, settlement. 3 William, c. 11, s. 6.

5. *Renting* 10*l.* *per Annum.* This gains a settlement, if resided on forty days. 13, 14 Charles II.

6. *Marriage.* As a general rule, the wife follows the husband's settlement; but if the husband has no settlement, or it is not known at his death, her own settlement is restored. And if the husband deserts his wife, her settlement remains.

7. *Estate.* No person shall be removed from any estate while he remains on it. 9 George I. c. 7. But no person gains a settlement by any estate whose purchase was less than 30*l.* *Ibid.*

Persons who have no settlement, as foreigners, or whose settlement cannot be known, as deserted infants, must be kept by the parish where they happen to be.

Certificates. This head is almost done away by the salutary law which will be noticed under

Removals. So much of 13, 14 Charles II. c. 12, as enables justices to remove persons likely to become chargeable, is repealed; and no person can now be removed till actually chargeable. 35 George III. c. 101, s. 1.

Justices may suspend removal of persons ill, either under a vagrant pass, or order of

removal; expense attending the suspension to be paid by the parish officers of the place to which the pauper is to be removed; on refusal to pay within three days, R. distress and sale, with costs, not exceeding 40*s.* J. 1. If out of the jurisdiction, warrant of distress to be backed by a justice having jurisdiction. Ap. to the sessions, if charges and costs exceed 20*l.* *Ibid.* s. 2.

Every person convicted of larceny or felony, or deemed a rogue and vagabond, or disorderly person, or who shall appear to two justices, on oath of one witness, to be a person of evil fame or a reputed thief, and shall not give a satisfactory account of himself and way of living; and every unmarried woman with child, shall be deemed actually chargeable, and be removed as such. *Ibid.* s. 6.

Person refusing to go with an order of removal, or returning when removed, P. commitment as a vagabond. J. 1. 13, 14 Charles II. c. 12, s. 3.

Parish officer refusing to receive a person so sent, P. bound to the assizes or sessions, to answer the contempt. J. 1. *Ibid.*

If removed into another county or jurisdiction, and the parish officers refuse to receive, P. 5*l.* A. to the poor of the place from which the pauper is removed. R. distress, and, in default, commitment for forty days. J. 1. of the jurisdiction to which removed. W. 2. 3 William, c. 11, s. 10.

Appeal from orders of removal to the sessions of the county from which the pauper was removed. 8, 9 William, c. 30, s. 6. It must be to the sessions of the county, and not of any corporate town.

Poor's *rate*, an assessment raised throughout England and Wales, for the temporary relief, or permanent maintenance, of all such persons, as from age, infirmity, or poverty, cannot themselves procure the means of subsistence. The first statute, or law made in England, which gives any particular directions concerning paupers, was 11 Henry VII. c. 2. it directs, "That every beggar, not able to work, shall resort to the hundred where he last dwelt, is best known, or was born; and shall there remain, upon pain of being set in the stocks, three days and three nights, with only bread and water, and then shall be put out of town." The insufficiency of this regulation soon became evident, and in 1531 an act was passed whereby the justices of every county were empowered to grant licences to poor, aged, and impotent persons, to beg within a certain precinct; but if they were found begging without licence, or beyond the limits specified, they were either to be whipped or set in the stocks. This however was a very inadequate mode of providing for the poor; and in 1536 an act was passed directing the governors and magistrates of counties, towns, and parishes, to provide for every aged, poor, and impotent person, who should have dwelt three years in any place, by means of the voluntary alms of charitable persons, which were to be collected for this purpose, in every parish. The act likewise directed, that sturdy vagabonds should be compelled to work, and that children from five to fourteen years of age, who lived in idleness, and were found begging, should be put to service.

Upon the destruction of the monasteries, from the charities of which the poor had derived their principle support, some further ineffectual attempts were made for their relief, by means of voluntary donations; but it was at length found necessary to stimulate public charity by a compulsory clause, in an act passed in 1563. This act directed, that if any parishioner shall obstinately refuse to pay reasonably towards the relief of the poor, or should discourage others, the justices of the peace, at their quarter-sessions, might tax him to a reasonable weekly sum, which if he refused to pay, they might commit him to prison. This may be considered as the origin of the poor's rate, which was rendered more general by an act passed in 1572, which directed that assessments should be made of the parishioners of every parish, for the relief of the poor of the same parish; which was the first regular and effectual parochial assessment for the poor in England. In 1601, further regulations were adopted on this subject; it being enacted by 43 Elizabeth, c. 2. that every parish should be bound to provide for its own poor; and that overseers of the poor should be annually appointed, who, with the church-wardens, should raise, by a parish rate, competent sums for this purpose: the mode in which the assessment was directed to be made was, that the justices of the peace of every county or place corporate, or the major part of them, at the general sessions to be held after Easter following, and so yearly, as often as they should think fit, should rate every parish to such a weekly sum of money as they should think convenient; which sum, so taxed, was to be yearly assessed by an agreement of the

parishioners within themselves, or in default thereof, by the churchwardens and petty constables, or by an order of the justices of the peace: and if any person refused or neglected to pay the portion of money so taxed, it might be levied by distress, and in default thereof, the person to be committed to prison till the money was paid. In this mode, or with very little variation, the poor's-rate has continued to be annally levied, but, as from the increase of population, the advanced price of all the necessaries of life, and other causes, the number of the poor has been greatly augmented, the sum raised for their support has progressively advanced to a very important magnitude.

According to an estimate, published by Dr. Davenant, of the sum raised by the poor's rate in England and Wales, in the latter part of the reign of Charles II. it amounted to 665,362*l*. As the number of the poor increased, it not only became necessary to raise a greater sum for their maintenance, but new cases arose with respect to the claims of individuals to this kind of relief, in consequence of which various acts were passed for explaining and amending the laws for the relief of the poor. In 1735, the House of Commons appointed a committee to consider of the existing laws relative to the maintenance and settlement of the poor, and what further provisions might be necessary for their better relief and employment. The committee came to several resolutions, which were agreed to by the house; the most important were, "that the laws in being, relating to the maintenance of the poor of this kingdom are defective; and, notwithstanding they impose heavy burdens on parishes, yet the poor, in most of them, are ill taken care of:" and, that it was very expedient, that the laws relating to the poor should be reduced into one act of parliament.

In 1776, a return was ordered to be made to parliament of the total expenditure on account of the poor, for one year, ending at Easter; pursuant to which, accounts were received from 14,113 parishes or places in England and Wales, from which it appeared, that the aggregate sum expended was 1,530,804*l*. 6*s*. 3*d*. and that there were then 1970 workhouses, capable of accommodating 89,775 persons. In 1786, a return was again ordered to be made of the average annual expenditure of the three preceding years, when accounts were obtained from 14,240 parishes or places, and the total was found to have increased in the short period of ten years to 2,004,238*l*. 5*s*. 11*d*. since which time a still greater increase has taken place.

In the year 1803, an act was passed for procuring returns relative to the expense and maintenance of the poor; from the answers and returns made pursuant thereto, the following particulars are derived.

Out of 14,611 parishes and places from which accounts were received, 3765 parishes maintain all, or part of, their poor in workhouses. The number of persons so maintained during the year, ending Easter 1803, was 83,468; and the expense, incurred therein, amounted to 1,016,445*l*. 15*s*. 3*d*. being at the rate of 12*l*. 3*s*. 6¾*d*. for each person maintained in that manner.

The number of persons relieved out of workhouses was 956,248, besides 194,052, who were not parishioners. The expense, incurred in the relief of the poor not in workhouses, amounted to 3,061,446*l*. 16*s*. 10¼*d*. A large proportion of those, who were not parishioners, appear to have been vagrants, and, it is probable, that the relief given to this class of poor could not exceed two shillings each, amounting to 19,405*l*. 4*s*. This sum being deducted from the above 3,061,446*l*. 16*s*. 10¼*d*. leaves 3,042,041*l*. 12*s*. 10¼*d*. being at the rate of 3*l*. 3*s*. 7*d*¾. for each parishioner relieved out of any workhouse.

The number of persons relieved in and out of workhouses was 1,039,716, and as the resident population of England and Wales, in the year 1801, appeared from the returns made under the population act to have been 8,872,980, the number of parishioners relieved from the poor's rate appears to be twelve in a hundred of the resident population.

The expenditure, in suits of law, removal of paupers, and expenses of overseers and other officers, amounted to 190,072*l*. 17*s*. ½*d*. and the sum expended in purchasing materials for employing the poor to 47,523*l*. 11*s*. 4¼*d*.

The poor of 293 parishes are stated in the returns to be farmed, or maintained under contract; and the poor of 764 parishes are maintained and employed under the regulations of special acts of parliament.

The total sum, raised by the poor's rate, and other parochial rates within the year, ending Easter 1803, was 5,348,205*l*. 9*s*. 3¾*d*. The average rate in the pound was, in England 4*s*. 4¼*d*. and in Wales 7*s*. 1½*d*. the average of England and Wales 4*s*. 5¼*d*.

The great increase of the sum thus levied upon the public, and its present magnitude, naturally suggest a doubt whether the established claim to this kind of relief may not have become, in many instances, the dependance of idleness, instead of the support of age and helplessness. It is also probable, that the laws, by which the poor's rate was originally established, had no relation to the pecuniary relief of the able bodied labourer, and that it was only meant for the relief of those, who either had not work, or who were unable to work. In later years however, it has been generally extended to the relief of the labourer; and the quantity of that relief has been measured by the high price of provisions, which is one of the principal causes of the great augmentation of the poor's rate.

Mr. Malthus, in his "Essay on the Principle of Population," advises the total abolition of this system of parochial relief, by proposing that a regulation should be made, declaring that no child born from any marriage, taking place after the expiration of a year from the date of the law, and that no illegitimate child, born two years after the same date, should ever be entitled to parochial assistance. To give a more general knowledge of this law, he proposes that the clergyman of the parish should, previously to every marriage, read a short address to the parties, stating the strong obligation on every man to support his own children, and the necessity, which had at length appeared, of abandoning all public institutions for their relief, as having produced effects totally opposite to those which were intended. See POPULATION.

POPPY, we have, under the word PAPAVER, given a botanical account of the plant; we are now to speak of it as productive of opium. The officinal poppy is a native of the southern parts of Europe, but it is thought to have been originally from Asia, where it is cultivated in great abundance. Opium, called also opium thebaicum, from its being anciently prepared chiefly at Thebes, has been long and highly celebrated as a medicine. It is imported into this country, and the continent of Europe, in flat cakes, covered with leaves to prevent their sticking together. It has a reddish-brown colour, and a strong peculiar smell. It is the chief narcotic now employed; it acts directly upon the nervous power, diminishing the irritability and mobility of the system. From the sedative power of opium, by which it allays pain, inordinate action, and restlessness, it is employed in various diseases. Besides the sedative power, it is known to act more or less as a stimulant, exciting the motion of the blood; and by the conjoined effort of the sedative and stimulant effect, opium has been thought to produce intoxication, a quality for which it is much used in the eastern countries. The manner in which this drug is collected in the east is as follows: when the capsules are about half grown, at sun set, they make two longitudinal double incisions, passing from below upwards, and taking care not to penetrate the internal cavity. The incisions are repeated every evening, until each capsule has received six or eight wounds; they are then allowed to ripen their seeds. If the wound were made in the heat of the day, a cicatrix would be too soon formed. The night dews favour the distillation of the juice. Early in the morning old women, boys and girls, collect the juice by scraping it off, and deposit the whole in an earthen pot, where it is worked by the hands in the open sun-shine until it becomes of a considerable thickness. It is then formed into cakes of a globular shape, and of about four pounds each in weight, and laid into little earthen vessels to be further dried. They are then covered over with poppy or tobacco leaves, and thus dried they are fit for sale.

From a variety of experiments made on a large scale, it is found that opium may be obtained from the poppy cultivated in this country, which in colour, consistence, taste, &c. is, in every respect, as good as that which is imported from foreign parts. It is thus procured: when the leaves die away and drop off, the capsules, being then in a green state, are cut in slits about an inch long, on one side of the head only: immediately on the incision being made, a milky fluid will issue out, which being of a glutinous nature, will adhere to the bottom of the incision; but some are so luxuriant, that it will drop from the head. The next day, if the weather should be fine, the opium will be of a greyish substance, and then may be scraped off with the edge of a knife, and in a day or two it will be of a proper consistence to make into a mass, and to be put in pots. The white poppy is commonly considered as the officinal plant, but any of the varieties may be employed indiscriminately, since no difference is discovered in their sensible qualities or effects.

The heads or capsules being boiled in water, impart a narcotic juice. The liquor

strongly pressed out, suffered to settle, clarified with whites of eggs, and evaporated to a due consistence, yields an extract possessing the virtues of opium, only in a much milder degree. This is called the syrup of the white poppy, and is adapted to the use of children. It may be observed that the seeds possess no narcotic powers: they consist of a simple farinaceous matter, united with an oil, and in some countries they are eaten as food.

POPULATION, the proportion of inhabitants which a country or district contains. The increase or diminution of the members of a state has at all periods been thought an object deserving the attention of governments; but very different opinions have been entertained on the subject.

Some ancient nations adopted regulations to prevent any augmentation of the number of citizens; but in modern times it has generally been thought proper to encourage population as essential to the strength and prosperity of a state. Positive regulations against the increase of population are superfluous and nugatory; it is limited in every country by the means of subsistence, and if it ever actually passes this barrier, it must, in a very short time, be restored to its former level. So long as there is a facility of subsistence, men will be encouraged to early marriages, and to a careful rearing of their children. In the American states, the inhabitants, particularly such as are engaged in agriculture, congratulate themselves upon the increase of their families, as upon a new accession of wealth, for the labour of their children, even in an early stage, soon redeems, and even repays with interest, the expence and trouble of rearing them. In such countries the wages of the labourer are high, for the number of labourers bears no proportion to the demand and to the general spirit of enterprise. In many European countries, on the other hand, a large family has become a proverbial expression for an uncommon degrée of poverty and wretchedness.

The obvious principle, that population is necessarily limited by the means of subsistence, has been stated, and conclusions drawn from it, by many different writers; but it has lately been discussed at great length in an "Essay on the Principle of Population," by Mr. T. R. Malthus, who has endeavoured to prove that population invariably increases where the means of subsistence increase, unless prevented by some very powerful and obvious checks; and that these checks, and the checks which repress the superior power of population, and keep its effects on a level with the means of subsistence, are all resolvable into moral restraint, vice, and misery. Under whatever denomination the causes which adjust population to the circumstances of the country may be classed, it is certain that they exist in every civilized country, and while the nature of man remains the same they must continue to exist, although operating in a greater or less degree according to the progress the country has made in cultivation, commerce, and political power. In the northern states of America, where the means of subsistence are more ample, the manners of the people more pure, and the impediments to early marriages fewer than in any of the modern states of Europe, the population was found to double itself for some successive periods every twenty-five years, while in Great Britain, where commerce and manufactures have created large towns, where an almost constant supply is wanting to recruit a formidable army and navy, and where many other causes exist which prevent any considerable increase, the population has not doubled itself in more than one hundred and fifty years.

If a powerful check to increase must exist in some form or other, Mr. Malthus observes, that it is clearly better it should arise from a foresight of the difficulty of rearing a family, and the fear of dependant poverty, than from the actual presence of pain and sickness; moral restraint, or the determination to defer or decline matrimony from a consideration of the inconveniencies or deprivations to which a large portion of the community would subject themselves by pursuing the dictate of nature, is therefore a virtue, the practice of which is most earnestly to be encouraged. If no man were to marry, who had not a fair prospect of providing for the presumptive issue of his marriage, population would be kept within proper bounds; men and women would marry later in life, but in the full hope of their reward they would acquire habits of industry and frugality, and inculcate the same in the minds of their children. Mr. Malthus does not actually propose that any restraint upon marriage between two persons of proper age should be enforced by law, but insists that the contract of marriages between persons who have no other prospect of providing for their offspring than by throwing them on a

parish, should not be, as it is at present, encouraged by law. With this view he suggests a plan for the gradual abolition of the poor laws; but, until the poor are more enlightened, and better instructed in moral duties, it is much to be feared that the total abolition of these laws would produce much more vice and misery than at present exists among them.

Although a knowledge of the state of the population has been deemed important in most countries, few attempts had been made to ascertain this circumstance with precision, till within a very late period. In the year 1757 a general enumeration was taken in the kingdom of Sweden, which has since been continued; but most of the other governments of Europe were satisfied with returns of the number of houses, families, or persons paying particular taxes. It remained for the new government of the United States of America to set the example of a complete enumeration throughout a very extensive territory, and apparently made with as much precision as the nature of the subject admits. The act of Congress, for the first census, passed the first of March, 1790; it directed the marshal of every district to superintend the enumeration of the state where he exercised his functions, and authorised him to call in what aid and assistance he might judge proper. He was ordered to make a return within nine months to the President of the United States, distinguishing in the return the number of free males under and above the age of sixteen years, the number of free females, and of slaves. The Indians, who might live in the districts, were not to be included in the list of population. Every assistant in the enumeration was directed, before transmitting his account to the marshal, to affix it in two or three of the most frequented places of assembly within his bounds, that it might receive any corrections which the inhabitants might suggest. In this manner the census was completed, and the result announced a population of 3,929,326 inhabitants, including 697,697 slaves. The inhabitants of the north-west territory were not included in this number, but the population of that part was then so inconsiderable, that it would have made no important difference in the total number. On the twenty-eighth of February, 1800, an act was passed for taking the second census, pursuant to which the returns were transmitted to the President in December, 1801. The particulars of this enumeration, with the totals of the former, are given in the following statement:

States.	Total 1791.	Free white Males.	Free white Females.	All other free persons.	Slaves.	Total 1801.
Maine	96,540	76,832	74,069	818	....	151,719
New Hampshire	141,885	91,258	91,740	852	8	183,858
Vermont	85,539	79,328	74,580	557	....	154,465
Massachusetts	378,787	205,135	211,258	6,452	....	422,845
Rhode Island	68,825	31,858	33,580	3,304	380	69,122
Connecticut	237,946	121,193	123,528	5,330	951	251,002
New York	340,120	287,094	268,122	10,374	20,613	586,203
New Jersey	184,139	98,725	95,600	4,402	12,422	211,149
Pensylvania	434,373	301,467	284,628	14,564	1,706	602,365
Delaware	59,094	25,033	24,819	8,268	6,153	64,273
Maryland	319,728	113,688	108,310	19,987	107,707	349,692
Virginia	747,610	264,399	254,275	20,507	346,968	886,149
Kentucky	73,677	93,961	85,915	741	40,343	220,960
North Carolina	393,751	171,648	166,116	7,043	133,296	478,103
South Carolina	249,073	100,916	95,339	3,185	146,151	345,591
Georgia	82,548	55,968	48,293	1,019	59,404	162,684
Tennessee	35,691	47,180	44,529	309	13,584	105,602
Territory N.W. of Ohio	....	24,433	20,595	337	....	45,365
Mississippi territory	....	2,907	2,272	182	3,489	8,850
Indiana territory	....	2,979	2,318	188	156	5,641
	3,929,326	2,194,002	2,109,886	108,419	893,331	5,305,638

POPULATION.

The most striking circumstance which this account exhibits, is the great increase which has taken place since the enumeration in 1791, the addition being more than a third part of the whole number of inhabitants at that period, or 1,376,312 persons. Should they continue thus to increase one third of their number in each succeeding ten years, they would, in about twenty-five years, equal the population of Great Britain, as it appeared by the account of 1801; but should they only make the same addition in each succeeding ten years as in the above period, it would require about forty years to attain the same degree of population.

The increase shown by the above account, being much greater than any other civilized nation can boast, it may be doubted, whether having already made such considerable progress, this increase will still continue; but the United States are so differently circumstanced from any European nation with respect to the means of subsistence, that while they preserve peace with other powers, the vast tracts of unsettled lands which they possess, will long continue to favour the greatest natural increase of the inhabitants, as well as attract emigrants from other countries.

Another peculiarity which these accounts present, is the proportion of males and females. In Great Britain, and most other parts of Europe, the number of females living has been found to exceed that of the males, although the difference is not so great as was formerly supposed; in America, however, the fact is the contrary, the number of the females being equal to that of the males only in three or four of the states, and taking the total numbers of males and females, the proportion is ninety-six females to one hundred males.

The population of Great Britain was long a subject of great uncertainty, both with respect to the actual number of inhabitants, and their increase or diminution; it became a subject of frequent controversy among writers on the internal policy and strength of the country, till it was at length set at rest by an act of parliament, passed 31st December, 1800, which directed a general enumeration of houses, families, and persons, to be named on the 10th March, 1801, in England and Wales, and in Scotland as soon as possible after that day. This difference was necessary, because in the colder climate of Scotland, it was not certain that all parts of the country would be easily accessible so early in the year. An abstract of the answers and returns made, was laid before both houses of parliament in December following, which, though unavoidably defective in some respects, furnishes much unexceptionable information on the subject.

SUMMARY OF ENUMERATION, 1801.

	HOUSES.			PERSONS.		
	Inhabited.	By how many families occupied.	Uninhabited.	Males.	Females.	Total.
England..................	1,472,870	1,787,520	53,965	3,987,935	4,343,499	8,331,434
Wales	108,053	118,303	3,511	257,178	284,368	541,546
Scotland	294,553	364,079	9,537	734,581	864,487	1,599,068
Army, including Militia.....................	......	......	...	198,351	......	198,351
Navy, including Marines	......	......	...	126,279	......	126,279
Seamen, in Registered Shipping	......	......	...	144,558	......	144,558
Convicts, on board the Hulks	......	......	...	1,410	......	1,410
Totals..	1,875,476	2,269,902	67,013	5,450,292	5,492,354	10,942,646

The islands of Guernsey, Jersey, Alderney, and Sark, the Scilly Islands, and the Isle of Man, were not comprised in the enumeration; the total population of these islands has been usually estimated at about 80,000. The number of houses in Ireland has been nearly ascertained by the collection of a hearth-money tax, from whence it has been computed that the population of that part of the united kingdom somewhat exceeds four millions of persons. Therefore, with a very moderate allowance for those places from which no returns were received, and for omissions in others, the total population of the united kingdom of Great Britain and Ireland amounted to 15,100,000 persons.

At the beginning of the preceding century, Dr. Davenant published an account of the total number of houses in England and Wales, according to the hearth books of Lady Day 1690; this account was probably as correct as the above, and a comparison of them shows an increase from 1690 to 1801 of 261,708 houses which at 5½ persons to a house makes an increase of 1,465,563 persons. This appears to be the least increase that can have taken place, but it has certainly been greater on account of the number of soldiers and seamen far exceeding those employed in 1690.

A circumstance which caused considerable disagreement in the estimates, which previously to the enumeration, had been formed on this subject, was the want of sufficient accounts to determine the proportion of persons to a house. Dr. Davenant and Dr. Brakenridge reckoned six persons to a house; while Mr. G. King allowed rather more than 4½ in London, $4\frac{1}{10}$ in the cities and market towns, and four in the villages. Dr. Price asserted that six persons to a house for London, and five to a house for all England was too large an allowance; but the fact now appears to be, that in England and Wales the proportion is 5¾ persons to a house, and in Scotland 5¼.

The proportion of inhabitants to a house differs very considerably in some of the counties of England; the chief cause of this difference is the large towns, and particularly the sea-ports which some of them contain, as in such places the inhabitants live more crowded together than in moderate sized inland towns. The difference in this respect between large towns and those of less extent will be shown with tolerable accuracy by the following statements.

Inhabitants.	Towns.	Persons to a House.
864,845	... London	7½
84,020	... Manchester	6¾
77,653	... Liverpool	6¾
63,645	... Bristol	6
43,194	... Plymouth	9¾
32,200	... Bath	7½
32,166	... Portsmouth	6
29,516	... Hull	6¼
28,366	... Newcastle	9

The other towns in England containing upwards of twenty thousand inhabitants, are the following:

Inhabitants.	Towns.	Persons to a House.
73,670	.. Birmingham	5
53,162	... Leeds	4¾
36,832	... Norwich	4¼
31,314	... Sheffield	4¾
28,861	... Nottingham	5¼

The latter are all manufacturing towns, the trade of which had for several years previously to the enumeration, been in a very distressed situation, and had reduced the population much below its usual standard; a few years of peace will restore the inhabitants which these towns had lost, and reduce in some degree the population of the principal out-ports.

Proportion of persons to a house in towns of a moderate size.

Inhabitants.	Towns.	Persons to a House.
7,909	... Devizes	5
7,668	... Salisbury	5¼
7,655	... Bury	5¾
7,579	... Gloucester	5¾
7,531	... Wellington	5¼
7,398	... Lincoln	5
7,020	... Northampton ...	5¼
6,828	... Hereford	5
6,730	... Newark	5
6,505	... Tiverton	5¼
5,794	... Taunton	5

The enumeration has not only ascertained with precision the proportion of inhabitants to the houses, but likewise the proportion of males and females. It has been long known that more male children come into the world than females, of which additional evidence is furnished by the registers of baptisms collected on this occasion, the total of the twenty-nine years for which returns were required, being 3,285,188 males, and 3,150,922 females, or 104 males born to 100 females. This approaches much nearer to equality, than the proportion which previous accounts had appeared to establish, and will probably be found nearer

the truth. It has been asserted, that although more males are born than females, there are more females living than males. This opinion appears to have been formed from accounts of places of small extent, or in which the males belonging to such places, who at the time were employed in the army and sea-service were not included; and if only the resident population is considered, there certainly will appear an excess of females in almost every part of Great Britain. In the maritime counties there appears to be on an average 110 females to 100 males, and in the inland counties 104 females to 100 males. There can be no sufficient reason assigned for a greater proportion of females residing in the counties which contain sea-ports, but their connection with males engaged in a seafaring life; and in reality the proportion of females is not greater in these counties than in the others, but it unavoidably appears so in consequence of persons in the navy and merchants service having been accounted for in a body, and therefore not being included in the returns of the parishes to which they belong. Of the total number of males in Great Britain, it appears that one in twenty-seven, or nearly four in 104, are in the army and militia, which corresponds with the appearance of an excess of females in the inland counties, whence most of our soldiers, but scarce any sailors, are supplied; and of the total number of males in Great Britain, the army, navy, and seamen in the merchants service, amount together to one in 11¼, or somewhat less than 10 out of 110; which agrees so nearly with the average excess of females in the maritime counties, that little doubt can remain that the appearance of an excess of females, has been caused merely by soldiers and seamen not being included in the parochial returns.

The total number of males, including the army, navy, &c. was 5,450,292; the total of females 5,492,354, exceeding the males by 42,062, which difference of less than one in 100, may be accounted for by emigration from this country to the East and West Indies, America, &c. very few females going from hence to reside in foreign parts in comparison with the number of males who are continually leaving the country in commercial pursuits, or from other motives. The result of the enumeration therefore strongly proves that the number of males and females living is as nearly equal as in a subject of this nature could be expected; and the circumstance of a greater proportion of males being born, appears a necessary provision for maintaining this equality, as providing against the greater adventitious mortality among males in consequence of the casualties to which they are exposed, and particularly from war and navigation.

An attempt was made to ascertain the population of France, by command of the government, in the tenth year of the Republic, but the account does not appear to have been very accurately taken. The total population of the 102 departments into which France was then divided, was stated at 33,104,343 persons, over an extent of about 185,600 square miles. This account included thirteen departments incorporated with the north of France, four departments in the south, and some smaller acquisitions comprehending in the whole 23,790 square miles, containing 5,114,419 inhabitants.

POPULUS, in botany, *poplar*, a genus of the Dioecia Octandria class and order. Natural order of Amentaceæ. Essential character: calyx of the ament a flat scale, torn at the edge; corolla turbinate, oblique, entire: female, stigma four-cleft; capsule two-celled; seeds many, pappose. There are eleven species; among which we shall notice the P. tremula, trembling poplar-tree, or asp, as it is called from the German *espe*, which is the general name for all poplars; it has a green smooth bark; the leaves at first breaking out are hairy above, and cottony underneath, but when full grown are smooth. Linnæus observes that they are rolled inwards at the edge, having two glands, running one into the other, on the inner side above the base; he also observes that the leaf-stalks are flatted towards the end, which occasions the perpetual trembling of the leaves with every breath of wind; the petioles being flat in the white and black poplars, as well as in this. Dr. Stokes accounts better for the phenomenon, from the plane of the long leaf-stalks being at right angles to that of the leaves, allowing them a much freer motion than could have taken place had their planes been parallel. The Highlanders of Scotland account for it, from a superstitious notion that our Saviour's cross was made of this tree, and that therefore the leaves can never rest.

PORANA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-cleft, in the fruit larger; corolla bell-shaped; style semibifid, longer, permanent; stigmas globular; pericarp two-valved. There is only one

species, *viz.* P. volubilis, a native of the East Indies.

PORCELAIN, a fine sort of earthenware, chiefly manufactured in China, and thence called china-ware.

The combination of silex and argil is the basis of porcelain; and, with the addition of various proportions of other earths, and even of some metallic oxides, forms the different varieties of pottery, from the finest porcelain to the coarsest earthenware.—Though siliceous earth is the ingredient which is present in largest proportion in these compounds, yet it is the argillaceous which more particularly gives them their character, as it communicates ductility to the mixture when soft, and renders it capable of being turned into any shape on the lathe, and of being baked.

The clays are native mixtures of these earths; but they are often rendered unfit for the manufacture of at least the finer kinds of porcelain, from other ingredients which they also contain.

The perfection of porcelain will depend greatly on the purity of the earths of which it is composed; and hence, the purest natural clays, or those consisting of silex and argil alone, are selected. Two substances have been transmitted to Europe, as the materials from which the Chinese porcelain is formed; which have been named KAOLIN and PETUNSE, which see; it was found difficult to procure, in Europe, natural clays equally pure, and hence, in part, the difficulty of imitating the porcelain of the east. Such clays, however, have now been discovered in different countries; and hence, the superiority to which the European porcelain has attained. The fine Dresden porcelain, that of Berlin, the French porcelain, and the finer kinds which are formed in this country, are manufactured of such clay, which, from the use to which it is applied, has received the name of porcelain earth, and which appears, in general, to be derived from the decomposition of the felspar of granite. It appears also that natural earths, containing magnesia, are used with advantage in the manufacture. The proportion of the earths to each other must likewise be of importance; and from differences in this respect arise, in part, the differences in the porcelain of different countries, as well as the necessity frequently of employing mixtures of natural clays. The argil communicates tenacity and ductility to the paste, so that it may be easily wrought: the silex gives hardness and infusibility; and, on the proper proportion of these depends, in a great measure, the perfection of the compound. The proportion of silex in porcelain of a good quality is, at least, two-thirds of the composition; and of argil, from a fifth to a third. Magnesia is of utility, by lessening the tendency which the composition of silex and argil alone has to contract in baking, and which is convenient in the manufacture. In the manufacture of the finer kinds of porcelain, the ingredients are carefully washed, dried, and ground by a mill to a very fine powder, which is passed through a sieve. This is made into a paste with water, which is well kneaded, so as to be uniform in composition. The vessels shaped from this paste are baked in earthen pots, to render them tolerably hard and compact: they are then covered with the materials for glazing, which, in the better kinds of porcelain, consist of a mixture of earths, which form a compound more vitrifiable than the porcelain itself.

These materials are diffused in a very fine powder in water, into which the baked vessels are dipped: the surface is thus covered with a thin crust, the water being absorbed. When dry, they are again placed in the earthen pots, and exposed to a very intense heat. The solid matter of the porcelain undergoes a semi-vitrification, whence it possesses all the hardness of glass, and has an additional value in being less brittle, and much more able to bear sudden alterations of temperature: it derives also much beauty from its semi-transparency and white colour. The glazing on the surface is, from its greater fusibility, more completely vitrified, and is, of course, more smooth and impervious. See GLAZING, ENAMELLING, &c.

PORCH, in architecture, a kind of vestibule supported by columns; much used at the entrance of the ancient temples, halls, churches, &c. See ARCHITECTURE. Such is that before the door of St. Paul's, Covent Garden. When a porch had four columns in front, it was called a tetrastyle; when six, hexastyle; when eight, octostyle, &c. See TETRASTYLE, &c.

PORCUPINE. See HISTRIX.

PORE, in anatomy, a little interstice or space between the parts of the skin, serving for perspiration. See CUTIS and PHYSIOLOGY.

PORES, are the small interstices between the particles of matter which compose bodies; and are either empty, or filled with some insensible medium.

Condensation and rarefaction are only performed by closing and opening the pores.

Also the transparency of bodies is supposed to arise from their pores being directly opposite to one another. And the matter of insensible perspiration is conveyed through the pores of the cutis.

Sir Isaac Newton shows, that bodies are much more rare and porous than is commonly believed. Water, for example, is nineteen times lighter and rarer than gold; and gold itself is so rare, as very readily, and without the least opposition, to transmit magnetic effluvia, and easily to admit even quicksilver into its pores, and to let water pass through it: for a concave sphere of gold hath, when filled with water, and soldered up, upon pressing it with a great force, suffered the water to ouze through it, and stand all over its outside, in multitudes of small drops like dew, without bursting or cracking the gold. Whence it may be concluded, that gold has more pores than solid parts, and consequently that water has above forty times more pores than solid parts. Hence it is that the magnetic effluvia passes freely through all cold bodies that are not magnetic; and that the rays of light pass, in right lines, to the greatest distances through pellucid bodies.

PORISM, in geometry, has been defined a general theorem, or canon, deduced from a geometrical locus, and serving for the solution of other general and difficult problems. But Dr. Simson defines it a proposition, either in the form of a problem or theorem, in which it is proposed either to investigate or demonstrate. Euclid wrote three books of Porisms, which are lost; and nothing remains in the works of the ancient geometricians on this subject, besides what Pappus has preserved in his mathematical collections. Dr. Simson, among the moderns, left behind him a considerable treatise on the subject of Porisms, which was printed at the expense of the late Earl Stanhope, who was himself a very able mathematician, and the patron of several persons who had distinguished themselves in that branch of science.

POROSTEMA, in botany, a genus of the Polyadelphia Polyandria class and order. Natural order of Lauri, Jussieu. Essential character: calyx six-parted, unequal; corolla none; filaments nine, with four anthers on each; capsule covered, four or six-celled, many-seeded. There is but one species, viz. P. guianensis, a native of the woods of Guiana.

PORPHYRY, in mineralogy, a name appropriated to that rock where grains or crystals of felspar are imbedded in a certain basis, as in horn-stone, pitch-stone, or indurated clay. There are five species of rocks belonging to the porphyritic formation; viz. 1. Horn-stone porphyry; the horn-stone, which serves as the base of this substance, is generally red or green, and incloses crystals of quartz and felspar. 2. Felspar porphyry; the base of this is red compact felspar, inclosing crystals of felspar and quartz. 3. Scenitic porphyry; containing crystals of hornblende, in addition to the other ingredients. 4. Pitch-stone porphyry; the base of which is red, green, brown, or black. 5. Clay porphyry; the base of which is indurated clay passing into horn-stone, it is of a reddish colour, and contains crystals of quartz and felspar. Horn-stone porphyry is the oldest of the class; and clay porphyry the most recent. The red porphyries are employed in ornamental architecture for columns.

PORT, a commodious place situated on the sea-coast, or at the mouth of a river, screened from the wind and the enterprizes of an enemy, with depth of water sufficient for ships of burden, and where vessels lie by to load and unload.

Ports are either natural or artificial; the natural are those formed by Providence, and the artificial such as are formed with moles running into the sea. The city of Constantinople is called "The Port," from its having one of the finest ports in Europe. All the ports and havens in England are within the jurisdiction of the county; and the Court of Admiralty cannot hold jurisdiction of any thing done in them. 30 Henry VI.

PORT *holes*, in a ship, are the holes in the sides of the vessel, through which are put the muzzles of the great guns. These are shut up in storms to prevent the water from driving through them. The English, Dutch, and French ships, have the valves, or casements, fastened at the top of the port holes, and the Spanish vessels aside of them.

PORTAL, in architecture, a little gate where there are two gates of a different bigness; also a little square corner of a room cut off from the rest by the wainscot, and forming a short passage into the room. The same name is also sometimes given to a kind of arch of joiners' work before a door.

PORTCULLICE, in fortification, is an assemblage of several large pieces of wood, joined across one another like a harrow, and each pointed with iron at the bottom. They are sometimes hung over the gateway of old fortified towns, ready to let down in

case of surprise, when the gates could not be shut.

PORTER, a kind of malt liquor, which differs from ale and pale beer in its being made with high-dried malt.

PORTGREVE, or PORTGRAVE, anciently the principal magistrate in ports and other maritime towns. The word is formed from the Saxon "port," and "geref," a governor. It is sometimes also written "portreve." It is said by Camden, that the chief magistrate of London was anciently called port-greve, which was exchanged by Richard I. for two bailiffs; and these again gave place, in the reign of King John, to a mayor, who was an annually elected magistrate.

PORTICO, in architecture, a kind of gallery on the ground, supported by columns, where people walk under covert.

PORTLAND-STONE, is a dull whitish species of stone, much used in buildings; it is composed of a coarse grit, cemented together by an earthy spar: it will not strike fire with steel, but makes a violent effervescence with nitric acid.

PORTLAND *vase*, a celebrated funeral vase which was long in the possession of the Baberini family; but which was some years since purchased for 1000 guineas by the Duke of Portland, from whom it has derived its present name. Its height is about ten inches, and its diameter, where broadest, six. There are a variety of figures upon it, of most exquisite workmanship, in bas relief, of white opaque glass, raised on a ground of deep blue glass, which appears black, except when held against the light. It appears to have been the work of many years, and there are antiquarians who date its production several centuries before the Christian era; since, as has been said, sculpture was declining in excellence in the time of Alexander the Great. Respecting the purpose of this vase, and what the figures on it were meant to represent, there have been a variety of conjectures. We shall, therefore, give a short account of the several figures, without noticing any of the theories or conjectures that have been made about them. In one compartment three exquisite figures are placed on a ruined column, the capital of which is fallen, and lies at their feet among other disjointed stones: they sit under a tree on loose piles of stone. The middle figure is a female in a reclining and dying attitude, with an inverted torch in her left hand, the elbow of which supports her as she sinks, while the right hand is raised and thrown over her drooping head. The figure on her right hand is a man, and that on the left a woman, both supporting themselves on their arms, and apparently thinking intensely. Their backs are to the dying figure, and their faces are turned to her, but without an attempt to assist her. On another compartment of the vase is a figure coming through a portal, and going down with great timidity into a darker region, where he is received by a beautiful female, who stretches forth her hand to help him: between her knees is a large and playful serpent. She sits with her feet towards an aged figure, having one foot sunk into the earth, and the other raised on a column, with his chin resting on his hand. Above the female figure is a Cupid preceding the first figure, and beckoning him to advance. This first figure holds a cloak or garment, which he seems anxious to bring with him, but which adheres to the side of the portal through which he has passed. In this compartment there are two trees, one of which bends over the female figure, and the other over the aged one. On the bottom of the vase there is another figure on a larger scale than the one we have already mentioned, but not so well finished nor so elevated. This figure points with its finger to its mouth. The dress appears to be curious and cumbersome, and above there is the foliage of a tree. On the head of the figure there is a Phrygian cap: it is not easy to say whether this figure be male or female. On the handles of the vase are represented two aged heads with the ears of a quadruped, and from the middle of the forehead rises a kind of tree without leaves: these figures are, in all probability, mere ornaments, and have no connection with the rest of the figures, or the story represented on the vase.

PORTLANDIA, in botany, so named in honour of the Duchess of Portland, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla club, funnel-shaped; anthers longitudinal; capsule five-cornered, obtuse, two-celled, two-valved, many-seeded, crowned with a five-leaved calyx. There are four species.

PORTMANTEAU, a cloak bag of cloth, leather, &c. in which the cloak, linen, and other habiliments of travellers are disposed and laid on the horse's crupper. The same name is also given to a piece of joiners' work fastened to the wall in a wardrobe,

armoury, &c. proper for the hanging on of cloaks, hats, &c.

PORTRAIT, POURTRAIT, or POURTRAITURE, in painting, the representation of a person, and especially of a face done from the life. In this sense we use the term portrait-painting, in contradistinction to history-painting, where a resemblance of person is usually disregarded. Portraits, when as large as the life, are usually painted in oil-colours; sometimes they are painted in miniature with water-colours, crayons, pastils, &c. See PAINTING.

PORTULACA, in botany, *purslane*, a genus of the Dodecandria Monogynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx bifid; corolla five-petalled; capsule one-celled, cut round, or three-valved. There are twelve species; of which P. oleracea, garden purslane, is an annual herbaceous plant, with a round, procumbent, succulent stem; diffused branches, often throwing out fibres at the joints; leaves wedge-shaped, oblong, blunt, fleshy, sessile, clustered, especially at the ends of the branches: flowers sessile, corollas yellow, spreading; it is a native of both Indies, China, and Japan.

PORTULACARIA, in botany, a genus of the Pentandria Trigynia class and order. Essential character: calyx two-leaved; petals five; seed one, three-sided and winged. There is but one species, *viz.* P. afra, a native of Africa.

POSITION, or the *rule of false* POSITION, otherwise called the *rule of* FALSHOOD, in arithmetic, is a rule so called, because in calculating on several false numbers taken at random, as if they were the true ones, and from the differences found therein, the number sought is determined. This rule is either single or double. Single position is when there happens in the proposition some partition of numbers into parts proportional, in which case the question may be resolved, at one operation, by this rule. Imagine a number at pleasure, and work therewith according to the tenor of the question, as if it were the true number: and what proportion there is between the false conclusion and the false proportion, such proportion the given number has to the number sought. Therefore the number found by argumentation shall be the first term of the rule of three; the second number supposed, the second term; and the given number, the third. Or the result is to be regulated by this proportion, *viz.* As the total arising from the error to the true total, so is the supposed part to the true one. Example, A, B, and C, designing to buy a quantity of lead to the value of 140*l.* agree that B shall pay as much again as A, and C as much again as B; what then must each pay?

Now suppose A to pay 10*l.* then B must pay 20*l.* and C 40*l.* the total of which is 70*l.* but should be 140*l.* Therefore, if 70*l.* should be 140*l.* what should 10*l.* be?

Answer, 20*l.* for A's share, which doubled makes 40*l.* for B's share, and that again doubled gives 80*l.* for C's share, the total of which is 140*l.* Double position is when there can be no partition in the numbers to make a proportion. In this case, therefore, you must make a supposition twice, proceeding therein according to the tenor of the question. If neither of the supposed numbers solve the proportion, observe the errors, and whether they be greater or less than the supposition requires, and mark the errors accordingly with the sign $\times$ and —.

Then multiply contrarywise the one position by the other error, and if the errors be both too great, or both too little, subtract the one product from the other, and divide the difference of the products by the difference of the errors. If the errors be unlike, as the one + and the other —, add the products, and divide the sum thereof by the sum of the errors added together: for the proportion of the errors is the same with the proportion of the excesses or defects of the numbers supposed to be the numbers sought: or the suppositions and their errors being placed as before, work by this proportion as a general rule, *viz.* as the difference of the errors if alike; or their sum, if unlike, to the difference of the suppositions, so either error to a fourth number, which accordingly, added to or subtracted from the supposition against it, will answer the question.

POSITION, in geometry, is a term sometimes used in contradistinction to magnitude: thus a line is said to be given in position, *positione data*, when its situation, bearing, or direction, with regard to some other line, is given: on the contrary, a line is given in magnitude, when its length is given, but not its situation.

POSITIVE, a term of relation sometimes opposed to negative; hence a positive quantity, in algebra, is a real or affirmative quantity, or a quantity greater than nothing; thus called in opposition to

a privative or negative quantity, which is less than nothing, and marked by the sign —. Positive quantities are designed by the character + prefixed or supposed to be prefixed to them.

POSITIVE, in music, denotes the little organ usually placed behind or at the feet of an organist, played with the same wind, and the same bellows, and consisting of the same number of pipes with the larger one, though those much smaller, and in a certain proportion: this is properly the chair-organ.

POSITIVE *degree*, in grammar, is the adjective in its simple signification, without any comparison; or it is that termination of the adjective which expresses itself simply, and absolutely, without comparing it with any other.

POSITIVE *electricity*. According to the Franklinian system, all bodies are supposed to contain a certain quantity of electricity: and those, that by any means, are made to contain more or less than their natural quantity, are said to be positively or negatively electrified. These electricities being first produced by the friction of glass and resin, were called by some philosophers vitreous and resinous; the former answering to the positive or plus electricity, the latter to the negative or minus electricity.

POSSE *comitatus*. The power of the county, is the attendance of all knights and others, above fifteen years of age, to assist the sheriff in quelling riots, &c.

POSSESSION is two-fold; actual, and in law: actual possession is, when a man actually enters into lands and tenements to him descended; possession in law is, when the lands or tenements are descended to a man, and he has not as yet actually entered into them.

POSSESSIVE, in grammar, a term applied to pronouns which denote the enjoyment or possession of any thing, either in particular or in common: as *meus*, mine, and *tuus*, thine; *noster*, ours, and *vester*, yours.

POST, a word synonimous with *courier*, which is supposed to be originally derived from horses for the conveyance of dispatches, being *positi*, or placed at convenient distances, as relays or changes for those fatigued, and unable to proceed the whole journey with the desired speed. Hence it has become the practice to term horses employed for this and similar purposes, post-horses; their riders, post-boys; the houses for the reception of letters thus conveyed, post-offices; and even the drivers of chaises, postilions; and their vehicles, post-chaises; it is natural, besides, to say, he who continues a journey on fresh horses, without stopping for more than necessary refreshment, rides post. The spaces between certain inns, for the reception of travellers in England, forming a post, varies from twelve to fifteen miles, beyond which it is deemed imprudent to urge a horse, without a long interval of repose; and the charges per mile for horses furnished from those inns, have occasioned continual discontent, and frequent general meetings of certain classes of the public.

Before the establishment of a system for the conveyance of important intelligence, and in the earliest state of society, it may be supposed, horses were seized, or, to use a modern term, put into requisition where they were wanted; though it is still more probable, that men were tutored to run from station to station, as is now the practice in the Eastern nations, whose couriers fly their prescribed distance with astonishing velocity, and delivering their dispatches to fresh persons, they are by this means conveyed almost as rapidly as by horses. The Emperor Trajan, appears to have been the first who ordained the keeping of horses for this purpose only, and the example has appeared so rational to succeeding generations, that it is highly probable, posting of every description has now reached its full possible perfection.

It was customary, in ancient times, to convey information by boats, and in chariots, exclusive of on foot and horseback; nay, even pigeons have been taught to fly from place to place, with letters attached to them; in England, men who conveyed letters were called carriers, which was certainly, in the then state of the roads, a much more appropriate term than the present, implying, in one acceptation, exceeding swiftness. Louis XI., King of France, established the first régular conveyance of this description in the year 1464, for the more speedy and certain information he thought it necessary to possess, concerning the state of his extensive dominions; the utility of the invention was too apparent to escape the observation of the surrounding continental nations, which adopted the idea, and each suited the regulations to their own peculiar circumstances; England, alone, seems to have preferred her old and tedious system of carriers, till the twelfth year of the reign of Charles II., when Parliament

passed an act which empowered the King to establish a post-office, and to appoint a Post-master General; from that time to the present, numerous other acts of the legislature have been made, to improve and amend the system, which, during the time of peace, is carried on by an incredible number of clerks, and officers, and receivers, and letter-carriers, whose regularity and punctuality are not to be exceeded in any department of the government. In the time of Queen Anne, Sir Thomas Frankland, and John Evelyn, Esquire, held the office of Post-master General jointly, and received a salary of 2000*l.* per annum, about which time the following notice appeared in the London Gazette. "These are to give notice, that by the act of Parliament for establishing a general post-office, all letters and packets directed to, and sent from places distant ten miles or above, from the said office in London, which, before the second of this instant, June, were received and delivered by the officers of the penny-post, are now subjected to the same rates of postage as general post letters; and that for the accommodation of the inhabitants of such places, their letters will be conveyed with the same regularity and dispatch as formerly, being first taxed with the rates, and stamped with the mark of the general post-office; and that all parcels will likewise be taxed at the rate of two shillings per ounce, as the said act directs."

Although the value of money has infinitely decreased since the above period, such has been the increase in commerce, and trade, and population, that the charges for the conveyance of letters is still comparatively moderate, as a single letter is sent one hundred and fifty miles for eight-pence. This may be attributed, in a great measure, besides, to the modern invention of mail coaches, for which the public are indebted to Mr. Palmer, who has not, however, reaped that advantage from it originally intended. Those that have travelled in these vehicles need not be informed of their rapid motions, nor of the constant uninterrupted assiduity of the coachmen, the guards, the officers of the different post-towns, and even of the hostlers, to expedite their progress, and to those who have not, and foreigners, the regulations under which they are placed, must give an exalted idea of the commercial character of the British nation.

At eight o'clock in the evening of every day, the mail coaches depart from London, freighted with such letters and packets as have been conveyed during the day, either to the office in Lombard-street, or to that place from the various receiving-offices scattered in every direction, by the letter-carriers, who walk through their districts ringing a bell from five o'clock to six, to collect those letters which have been delayed to that late hour. The coaches, which proceed to London from all parts of the kingdom, regulate their movements so as to arrive by six o'clock each morning, and from that time the sorters at Lombard-street are employed in preparing the letters for the different carriers waiting to receive them, who generally complete their delivery by twelve at noon.

Newspapers are conveyed gratis to all parts of the country, and if frivolous, vexatious, or malicious letters are sent through the medium of the post-office, upon a proper representation the money is returned; persons are also appointed to open such letters as may be directed to individuals improperly, or who cannot be found, when they are carefully inclosed in an envelope, explaining why the seal has been violated, and returned to the writer. Letters directed to any part of England, may be sent without paying; or the receiver will take the postage, and the receipt, or non-payment, is explained to the carriers by marks stamped on the letter; but all letters sent out of England must be payed for on putting them into the office. Other marks, pointing out the day and hour of putting the letter into the receiver's hands, prevent the possibility of neglect without discovery, and so great is the vigilance of the officers, that though millions of money pass through the post-office, it is a very rare circumstance that dishonesty is discovered in the sorters or carriers: when an individual commits a theft of this description, he is pursued with unrelenting severity to punishment, and the office makes good the loss.

The general post-office was originally situated in Cloak-lane, near Dowgate, whence it was afterwards removed to the Black Swan, in Bishopsgate-street, and finally to the mansion of Sir Robert Vyner, in Lombard-street; and although it has been repeatedly enlarged and improved, and may answer for the purposes required, yet it must be admitted, that such an establishment requires an uniform and superb building.

The penny-post, as it was termed for

more than a century, originated from the public spirit of a merchant, named Docwra, and a Mr. Murray, who, with much difficulty and great expense, in the reign of Charles II., proceeded so far as to establish it; but, strange and perverse as it may appear, every species of opposition and misrepresentation attended its progress, both from the public and the government, and, after a trial with the latter in the court of King's Bench, the projectors had the mortification to find it adjudged to belong to the Duke of York, as a branch of the general post-office.

In an advertisement issued by them, in 1681, they say, "that undertakers have set up, and hitherto carried on the said practice with much pains and industry, and at the expence of a great sum of money, and are as desirous to continue it for the public service of their native place, as to benefit themselves thereby; yet they have met with much opposition, and many discouragements from the self-interested, the envious, and the ignorant: from the last of which (to pass by the others at present) there are daily complaints of the delays of letters causelessly charged on the office, which hath proved very injurious to the progress and prosperity of their honest design, and hindering the inhabitants from reaping the advantage and conveniency thereof." After some explanations how the delay complained of occurred through the carelessness of persons not connected with the undertaking, they add, "for some remedy to prevent such unjust reflections for the time to come, and that any person may discover where the fault lies, if his letter be delayed, the undertakers have provided stamps of the like form in the margin, (similar to those still used) which shall be set on each letter every hour of the day; (at the time they are given out of their office for delivery) and all persons are to expect their letters in an hour (little more or less) after the time stamped, according as the distance is further from, or nearer to, the office from whence they are sent; and if people will but consider, that there must be an hour's time allowed for collecting every round of letters, another for sorting and distributing, and a third for delivery, (besides an over-allowance for remote parts) they would not so often mistake in their reckonings, and expect a letter should go or come as soon as if a special messenger were immediately sent away with it, although they hope, that all ingenuous and thinking persons do find such dispatches as do answer their reasonable expectations."

An establishment of decided and obvious utility, like that of the penny-post, could not fail of succeeding in time, and accordingly we find, it has flourished for more than a hundred years; but well-founded complaints were sometimes urged against it during that period, which at length induced the government to take it under their immediate inspection, at the close of the last century, when, in order to meet the increased expences of every portion of the undertaking, it was determined to double the charge, and from that period it received the denomination of the two-penny post. In order to facilitate the conveyance of letters and packets, boys are employed, who ride small swift horses to and from the principal office situated in Gerard-street, Soho, where may be seen a miniature copy of the proceedings at the general post-office, already described.

POST-*office*, a general post-office, was erected 12 Charles II. c. 35. It was made perpetual, and part of the general fund, 3 George I. c. 7. The postmaster is not like a common carrier, and is not answerable for the loss of any money by post, nor can the country postmaster add any charge to the postage for carrying the letters out to the inhabitants of the town. The case has been several times tried and decided. A principal object in the erection of the post-office was in order to have the means of inspecting letters of individuals, and discovering attempts against the Government, (see the Ordnance 1657); and now letters may be opened by an order from a Secretary of State. For this, and other purposes, there are several penalties levied upon persons carrying or sending letters by private conveyance. Letters coming by private ships from abroad, and even letters belonging to the owners must also pass through the post-office.

Post, in the military art, is any place or spot of ground, fortified or not, where a body of men may make a stand and fortify themselves, or remain in a condition to fight an enemy. Hence it is said, that the post was relieved, the post was taken sword in hand, &c.

Post, *advanced*, is a spot of ground seized by a party to secure the army, and cover the posts that are behind.

POSTERN, in fortification, is a small gate generally made in the angle of the flank of a bastion, or in that of the curtin, or near the orillon, descending into the ditch;

by which the garrison may march in and out unperceived by the enemy, either to relieve the works, or to make private sallies, &c.

POSTIL, a name anciently given to a note in the margin of the bible, and afterwards to one in any other book posterior to the text.

POSTING, among merchants, the putting an account forward from one book to another, particularly from the journal or waste-book to the ledger.

POSTULATE, in mathematics, &c. is described to be such an easy and self-evident supposition, as needs no explication or illustration to render it intelligible; as, that a right line may be drawn from one point to another. That a circle may be described on any centre given, of any magnitude, &c.; however, authors are not well agreed as to the signification of the term postulátum; some make the difference between axioms and postulata to be the same as that between theorems and problems; axioms, according to those authors, being truths that require no demonstration. But others will have it, that axioms are primitive and common to all things, partaking of the nature of quantity, and which therefore may become the objects of mathematical science: such as number, time, extension, weight, motion, &c. and that postulata relate particularly to magnitudes, strictly so called, as to things having local extension, such as lines, surfaces, and solids; so that in this sense of the word postulatum, Euclid, besides axioms, or those principles which are common to all kinds of quantities, has assumed certain postulata to be granted him peculiar to extensive magnitude. Hence several of the principles assumed in his Elements, and ranked among the axioms by the moderns, are by Proclus ranked among the postulata, which has induced Dr. Wallis to judge, that the last of the two senses given to the term postulatum is most agreeable to the meaning of the ancient geometers.

POSTURE, in painting and sculpture, the situation of a figure with regard to the eye, and of the several principal members thereof with regard to one another, whereby its action is expressed. A considerable part of the art of a painter consists in adjusting the postures, in giving the most agreeable postures to his figures, in accommodating them to the characters of the respective figures, and the part each has in the action, and in conducting and pursuing them throughout.

POTAMOGETON, in botany, *pondweed*, a genus of the Tetrandria Tetragynia class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: calyx none; petals four; style none; seeds four. There are fourteen species; these are perennial, herbaceous plants, inhabitants of the water.

POTASH, in chemistry, a substance which is procured from the burnt ashes of vegetables, hence the termination *ash*; the prefix *pot* was given on account of its being prepared in iron pots. It obtained the name of vegetable alkali, because it was supposed to exist only in vegetable substances: and being prepared from nitre and tartar, it was called the "alkali of nitre," and likewise "salt of tartar," a name by which it is still known in the shops. By some it is distinguished by the name of "kali," the plant from which it was originally procured. This substance, in its rough state, is prepared by burning wood, or other vegetable matter, and thus reducing them to ashes. The ashes are washed repeatedly with fresh waters, till the liquid comes off perfectly tasteless. The liquid thus obtained is evaporated, and the salt obtained is potash. If this substance is exposed to a red heat, many of the substances which are mixed with it are driven off, and what remains is much whiter, and on account of its colour it is called "pearl-ash." In this state it is deemed sufficiently pure for the ordinary purposes of life, though by no means adapted to the purposes of the experimental chemist. Even when apparently freed from all extraneous substances, it is found to possess very different properties after having been subjected to certain processes. In one state it is mild and inactive; in another extremely acrid and corrosive. In the former case it is united with carbonic acid gas, and is a carbonate of potash, and not pure potash. When deprived of this acid gas, it is powerful, corrosive, and highly caustic. Different methods have been proposed by different chemists to obtain this substance quite pure: we shall transcribe that given by Professor Lowitz, of Petersburgh. He boils in an iron pot for two or three hours any quantity of potash with double its weight of quicklime, and eight times the weight of the whole mixture of distilled or rain water. The liquor is to be set by to cool, and then filtered and

evaporated, till a thick pellicle is formed on the surface. It is then set by till crystals are formed on it, which are crystals of extraneous salts, that are to be removed. The evaporation is to be continued, and the several pellicles removed as fast as they are formed. When the fluid ceases to boil, and no more pellicles arise, it is removed from the fire, and kept stirring till it is cold. It is then dissolved in double its weight of water; the solution is filtered and evaporated in a glass retort, till regular crystals begin to be deposited. When a sufficient quantity has been formed, the liquid is decanted, and the salt is re-dissolved after it is suffered to drain, in the same quantity of water. The decanted liquor is preserved in a well-closed bottle for several days, till it subside and become clear. It is then decanted, evaporated, and crystallised again, and the process repeated as long as the crystals afford with the least quantity of water solutions that are perfectly limpid.

Potash thus obtained is a white solid substance, which is susceptible of crystallisation in long compressed, quadrangular prisms, terminating in sharp-pointed pyramids. These crystals, which are only obtained from very concentrated solutions are soft and deliquescent. The taste is extremely acrid; and it is so corrosive, that it destroys the texture of the skin the moment it touches it: hence it has derived the name of caustic, and is employed in surgery for the purpose of opening abscesses, or for destroying excrescences. Its specific gravity is about 1.7. By a similar mode to that above described, pure soda may be prepared, substituting the carbonate of soda for the pearl-ash. They both possess the following properties:—1. They convert vegetable blues into a green colour. 2. They powerfully attract moisture. 3. They readily dissolve in water, and produce heat during the solution. They are not volatilised by a moderate heat, hence they are called fixed alkalies. Fixed alkalies have till very lately been numbered among the simple substances, not, however, without exciting in the minds of chemists a suspicion that they were compounds. Professor Davy has, in the course of the present and preceding years, put the matter beyond all doubt, and has proved to the satisfaction of every chemist, that they are compound of oxygen and certain metallic bases, to which he has given the names of

POTASIUM, and SODIUM, or SODAIUM. Of these, and of the experiments which led to the discoveries, we shall proceed to give some account, having attended the repetition of his experiments at the lectures delivered last spring at the Royal Institution. Mr. Davy, in his first attempts to decompose the alkalies, made use of the aqueous solutions, and failed. He next made use of the potash in a state of igneous fusion, which he brought within the sphere of the galvanic battery: with this also he was unsuccessful in the main point; but some brilliant phenomena were produced. The potash appeared a conductor in a high degree: a most intense light was exhibited at the negative wire, and a column of flame, which seemed to be owing to the developement of combustible matter, arose from the point of contact. Mr. Davy next tried several experiments on the electrization of potash rendered fluid by heat, with the hope of being able to collect the combustile matter, but he was still unsuccessful, "and I only," says he, "attained my object by employing electricity as the common agent for fusion and decomposition." Potash perfectly dried by ignition is a non-conductor; by a very slight addition of moisture, which does not perceptibly destroy its aggregation, it is rendered a conductor, and in this state it readily fuses and decomposes by strong electrical powers. A small piece of pure potash was placed upon an insulated disc of platina, connected with the negative side of the battery, in a state of intense activity; and a platina wire, communicating with the positive side, was brought in contact with the upper surface of the alkali, a vivid action took place, and the potash began to fuse at both points of electrization. There was a violent effervescence at the upper surface; at the lower, or negative surface, there was no liberation of elastic fluid; but small globules, having a high metallic lustre, appeared; these were similar in visible character to quicksilver: some of them burnt with explosion and bright flame as soon as they were formed, and others remained, and were merely tarnished, and finally covered with a white film, which formed on them. "These globules," said the professor, "numerous experiments soon shewed to be the substance I was in search of, and a peculiar inflammable principle the basis of potash. I found that the platina was in no way connected with the result, except as the medium for exhibiting the electrical powers of decomposition; and a substance of the same kind was produced when pieces of copper, silver, gold, plum-

bago, or even charcoal, were employed for completing the circuit."

Soda, when acted upon in the same manner, exhibited an analogous result, and these effects equally took place in the atmosphere, and when the alkali was acted upon in the vacuum of an exhausted receiver; but these globules could not in either case be produced from crystallized alkalies. When a globule of the base of potash was exposed to the atmosphere, it immediately attracted oxygen, and a white crust formed upon it, which proved to be pure potash. When the globules were strongly heated and then suspended in oxygen gas, a rapid combustion with a brilliant white flame was produced, and these metallic globules were converted to an alkali, whose weight greatly exceeded that of the combustible matter consumed. When Mr. Davy had thus detected the basis of the fixed alkalies, he had considerable difficulty to preserve and confine them, so as to examine their properties and submit them to experiments. He found, however, at length, that in recently distilled naphtha they may be preserved many days, and that their physical properties may be easily examined in the atmosphere, when they are covered by a thin film of it. The basis of potash, at 60° Fahrenheit, is only imperfectly fluid; at 70° it becomes more fluid; and at 100° its fluidity is perfect, so that different globules may be easily made to run into one. At 50° it becomes a soft and malleable solid, which has the lustre of polished silver; and still at about the freezing point of water it becomes harder and brittle, and when broken in fragments exhibits a crystallised texture, of perfect whiteness and high metallic splendour. To be converted into vapour, it requires a temperature approaching that of the red heat. It is an excellent conductor of heat, and a perfect conductor of electricity.

Resembling the metals in all these properties, it is, however, remarkably different from any of them in specific gravity; for it will not sink in double distilled naphtha, whose specific gravity is only .770, that of water being considered as 1.000. Mr. Davy has determined by experiment that its specific gravity is to that of mercury as 10 to 223, which gives a proportion to that of water nearly as 6 to 10; so that it is the lightest fluid body known. When this substance is introduced into oxymuriatic acid gas, it burns spontaneously with a bright red light, and muriate of potash is formed. When thrown upon water, it decomposes it with great violence, and an instantaneous explosion is produced with brilliant flame, and a solution of pure potash is the result.

When a globule is placed upon ice, not even the solid form of the two substances can prevent their union; for it instantly burns with a bright flame, and a deep hole is made in the ice, which is found to contain a solution of potash. When a globule is dropped upon moistened turmeric paper, it immediately burns, and moves rapidly upon the paper, as if in search of moisture, leaving behind it a deep reddish brown trace. So strong is the attraction of the basis of potash for oxygen, that it discovers and decomposes the small quantities of water contained in alcohol and ether, even when they are carefully purified. When thrown into the mineral acids, it inflames and burns on the surface. In sulphuric acid, sulphate of potash is formed; in nitrous acid, nitrous gas is disengaged, and nitrate of potash formed. When brought in contact with a piece of phosphorous, and pressed upon, there is a considerable action: they become fluid together, burn, and produce phosphate of potash. When a globule is made to touch a globule of mercury about twice as large, they combine with considerable heat; the compound is fluid at the temperature of its formation: but when cool it appears as a solid metal, similar in colour to silver. If this compound be exposed to air, it rapidly absorbs oxygen; potash which deliquesces is formed; and in a few minutes the mercury is found pure and unaltered.

When a globule of the amalgam is thrown into water, it rapidly decomposes it with a hissing noise, potash is formed, hydrogen disengaged, and the mercury remains free. The basis of potash readily reduces metallic oxides when heated in contact with them. It decomposes common glass by a gentle heat, and at a red heat effects a change even in the purest glass. Mr. Davy has discovered that its base, like that of potash, is white, opaque, and has the lustre of silver. The property of welding, which belongs to iron and platina, at a white heat only, is possessed by this substance at common temperatures. It is very similar, in its more obvious properties to the base of potash; but it has greater specific gravity, being to that of water nearly as nine to ten, or as .9348 to 1.0000. In oxygen gas it produces a white flame, and sends forth bright sparks, occasioning a very beautiful effect. In oxy-muriatic acid gas it burns vividly, with numerous scintillations of a bright red

colour. In the quantity of $\frac{1}{70}$, it renders mercury a fixed solid, of the colour of silver, and forms an alloy with tin. When amalgamated with mercury, the amalgam will combine with other metals.

Mr. Davy tried this with iron and platina, and had reason to believe that these latter metals remain in combination with the mercury, even when deprived of the new substance by exposure to the air. From several curious and ingenious experiments to ascertain the proportions of the bases and oxygen in the two fixed alkalies, he concludes that 100 parts of potash consist of about 84 basis, and 16 oxygen; and 100 parts of soda consist of about 76 or 77 basis, and 24 or 23 oxygen; or that potash may be considered as consisting of about 6 parts basis, and 1 of oxygen; and soda of 7 basis, and 2 oxygen. In reply to the question, whether the bases of potash and soda should be called metals, it may be said that they agree with metals in opacity, lustre, malleability, conducting powers as to heat and electricity, and in their qualities of chemical combination. Even their low specific gravity does not appear a sufficient reason for making them a new class; for amongst the metals themselves there are remarkable differences in this respect, platina being nearly four times as heavy as tellurium; and tellurium is not much more than six times as heavy as the basis of soda. Conceiving the basis of the two fixed alkalies to be metals, Mr. Davy has named one Potasium, and the other Sodium; adopting that termination which, by common consent, has been applied to other newly discovered metals.

On an examination of the volatile alkali, and after a great number of complex and tedious experiments, Mr. Davy saw reason to conclude that ammonia contains oxygen as an essential ingredient, and that this cannot well be estimated at less than 7 or 8 parts in the hundred: this body may therefore, as he says, be considered as the principle of alkalescence, with as much reason as the French have made it the principle of acidity. After making some general remarks on the preceding facts, he suggests the probability that the muriatic, fluoric, and boracic acids, all contain oxygen as one of their constituent principles. The earths of barytes and strontian, as being most analogous to the alkalies, were likewise examined, and both yielded oxygen. In concluding this very important communication, Mr. Davy remarks that an immense variety of objects of research is presented in the powers and affinities of the new metals produced from the alkalies. In themselves they will undoubtedly prove powerful agents for analysis; and having an affinity for oxygen, stronger than any other known substances, they may possibly supersede the application of electricity to some of the undecompounded bodies. Further experiments, it is said, have enabled Mr. Davy, since his communication to the Royal Society, from which the above has been partly abridged, to decompose in the most satisfactory manner, the barytes and strontites, and to show that the other alkaline earths are oxides of highly combustible metals. It cannot now be doubted that, in the hands of this great chemist, other bodies, hitherto, deemed simple, or at least never yet analysed, will speedily yield to the powers either of the highly inflammable metals already discovered, or of a still further increase of the galvanic battery. Mr. Davy has decomposed carbonic acid by means of those metals, and has oxydated them by muriatic acid; and an excellent writer says, "it is now by no means improbable that charcoal itself hitherto regarded as the most refractory of all substances, may be decomposed by the new instruments; and that the means of obtaining it pure, and even chrystallized, shall at last be found; a discovery which would enable art to vie with nature in the fabrication of her most valuable produce." At any rate to use the words of the Professor himself: "In sciences kindred to chemistry, the knowledge of the nature of the alkalies, and the analogies arising in consequence, will open many new views; they may lead to the solution of many problems in geology, and show that agents may have operated in the formation of rocks and earths, which have not hitherto been suspected to exist." See Philosophical Transactions of the Royal Society for 1808. Part I.

POT *stone*, in mineralogy, a species of the Clay genus. The colour of this mineral is a greenish grey of different degrees of intensity. It occurs massive. The internal lustre is glistening and pearly. Fracture, sometimes curved, foliated, sometimes imperfectly slaty. It is soft, feels greasy and difficultly frangible. It is found in beds with serpentine, at Como in the Grisons; in some parts of Saxony, and in Hudson's Bay. It is very nearly allied to indurated talc. It is refractory in the fire and may be used for lining furnaces. It may be

turned in a lathe and made into a variety of vessels fit for culinary and other purposes.

POTATOE, in botany, the English name for a species of the tuberose-rooted Solanum. See SOLANUM.

POTENT, or POTENCE, in heraldry, a term for a kind of a cross, whose ends all terminate like the head of a crutch. It is otherwise called the Jerusalem cross.

POTENTILLA, in botany, *cinquefoil*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx ten-cleft; petals five; seeds roundish, naked, fastened to a small juiceless receptacle. There are thirty-two species, chiefly natives of the South of Europe.

POTERIUM, in botany, *burnet*, a genus of the Monoecia Polyandria class and order. Natural order of Miscellaneæ. Rosaceæ, Jussieu. Essential character: male, calyx four-leaved; corolla four-parted; stamina thirty to forty: female, calyx four-leaved; corolla wheel-shaped, five-parted; pistils two; berry formed of the hardened tube of the corolla. There are five species.

POTHOS, in botany, a genus of the Tetrandia Monogynia class and order. Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: spathe; spadix simple, covered; calyx none; petals four; stamina four; berries two-seeded. There are thirteen species.

POTTERY, the manufacture of earthen ware, or the art of making earthen vessels. The inferior kinds of porcelain, or pottery, are prepared by the same process as that which has been described under the word PORCELAIN; less pure, but more fusible materials being employed, and of course a less degree of heat being applied.

The better kinds of English stone-ware are composed of pipe-clay, amd pounded flints. The yellow stone-ware is made of the same materials, in other proportions. The first is glazed by throwing sea-salt into the furnace in which it is baked, when the heat is strong; the salt is converted into vapour, and this, being applied to the surface of the stone-ware, vitrifies it, and forms an excellent glazing. The yellow stone-ware is glazed by dipping the baked ware in water, in which is suspended a mixture of pounded flint, glass, and oxide of lead. In the glazing of some kinds of stone-ware, oxide of tin enters into the composition with the oxide of lead, and gives a whiter glaze. All the coarser kinds of pottery are glazed with oxide of lead; this promoting so much the fusion and vitrification, that the low heat at which they are baked is sufficient.

The wheel and lathe are the chief, and almost the only, instruments used in pottery: the first for large works, and the last for small. The potter's-wheel consists principally in the nut, which is a beam or axis, whose foot or pivot plays perpendicularly on a free-stone sole or bottom. From the four corners of this beam, which does not exceed two feet in height, arise four iron-bars, called the spokes of the wheel; which, forming diagonal lines with the beam, descend, and are fastened at bottom to the edges of a strong wooden circle, four feet in diameter, perfectly like the felloes of a coach-wheel, except that it has neither axis nor radii, and is only joined to the beam, which serves it as an axis by the iron-bars. The top of the nut is flat, of a circular figure, and a foot in diameter: and on this is laid the clay which is to be turned and fashioned. The wheel, thus disposed, is encompassed with four sides of four different pieces of wood fastened on a wooden frame; the hind-piece, which is that on which the workman sits, is made a little inclining towards the wheel; on the fore-piece are placed the prepared earth; on the side-pieces he rests his feet, and these are made inclining, to give him more or less room. Having prepared the earth, the potter lays a round piece of it on the circular head of the nut, and, sitting down, turns the wheel with his feet till it has got the proper velocity; then, wetting his hands with water, he presses his fist or his fingers-ends into the middle of the lump, and thus forms the cavity of the vessel, continuing to widen it from the middle; and thus turning the inside into form with one hand, while he proportions the outside with the other, the wheel constantly turning all the while, and he wetting his hands from time to time. When the vessel is too thick, he uses a flat piece of iron, somewhat sharp on the edge, to pare off what is redundant; and when it is finished, it is taken off from the circular head, by a wire passed underneath the vessel.

The potter's lathe is also a kind of wheel, but more simple and slight than the former; its three chief members are an iron-beam or axis three feet and a half high, and two feet and a half diameter, placed horizontally at the top of the beam, and serving to form the vessel upon: and an-

other large wooden wheel, all of a piece, three inches thick, and two or three feet broad, fastened to the same beam at the bottom, and parallel to the horizon. The beam or axis turns by a pivot at the bottom in an iron stand. The workman gives the motion to the lathe with his feet, by pushing the great wheel alternately with each foot, still giving it a greater or lesser degree of motion, as his work requires. They work with the lathe, with the same instruments, and after the same manner, as with the wheel. The mouldings are formed by holding a piece of wood or iron, cut in the form of the moulding, to the vessel, while the wheel is turning round, but the feet and handles are made by themselves, and set on with the hand; and if there be any sculpture in the work, it is usually done in wooden moulds, and stuck on piece by piece on the outside of the vessel.

POUCH, in military affairs, a case of black stout leather, with a flap over it, which is generally ornamented by a brass crown, &c. for the battalion men; a fuse for the grenadiers; and a bugle-horn for the light infantry. The pouch hangs from a buff cross belt over the left shoulder, and is worn in that manner by the infantry for the purpose of carrying the ammunition.

POULTICE. See PHARMACY.

POUNCE, gum sandaric pounded and sifted very fine, to rub on paper, in order to preserve it from sinking, and to make it more fit to write upon.

POUNCE is also a little heap of charcoal dust, inclosed in a piece of muslin, or some other open stuff, to be passed over holes pricked in a work, in order to mark the lines or designs thereof on paper, silk, &c. placed underneath; which are to be afterwards finished with a pen and ink, a needle, or the like. This kind of pounce is much used by embroiderers, to transfer their patterns upon stuffs; by lace-makers, and sometimes also by engravers.

POUND, a certain weight, which is of two kinds; *viz.* the pound troy, and the pound avoirdupois; the one is divided into 12 ounces, the other into 16. The pound troy is to the pound avoirdupois as 576 to 700.

POUND also denotes a money of account; so called because the ancient pound of silver weighed a pound troy. See MONEY.

POUND, in law, any place inclosed to keep beasts in; a common pound belongs to a lordship, or village, and there ought to be such a pound in every township. Some persons have of late very reasonably complained of the ancient practice of keeping beasts for many days, in a common pound, without food; and it would seem well if there could be some remedy in this respect, and the constable or others were bound to give them sufficient food, to be repaid by the owner.

The use of the pound is to put cattle in which have been taken trespassing on other persons lands, and they are to remain there for some days, when the Lord of the Manor takes the cattle in his possession, and they are cried in three neighbouring market towns, and if not claimed within a year and a day are sold as estrays, and the damage they have done is paid out of the produce.

POURSUIVANT, or PURSUIVANT, in heraldry, the lowest order of officers at arms. See COLLEGE and HERALDRY. The Poursuivants are properly attendants on the Heralds, when they marshal public ceremonies. Of these, in England, there were formerly many; but at present are only four, *viz.* Blue-mantle, Rouge-cross, Rouge-dragon, and Portcullice. In Scotland there is only one King at Arms, who is stiled Lion, and has no less than six Heralds, and as many Pursuivants, and a great many Messengers at Arms, under him.

POWDER, a dry medicine well broken, either in a mortar, by grinding, or by chemical operations. See PHARMACY.

POWDER, *fulminating*. When three parts of nitre, two parts of potash, and one of sulphur, are previously well dried, and mixed together by trituration, they form a compound which is known by the name of fulminating powder. A few grains of this mixture exposed to heat in an iron ladle, first melt, assuming a darker colour; and when the whole is in fusion, there is a violent explosion. The heat should be applied slowly and gradually, till it is completely fluid, and then by bringing it nearer the heat, the full effect of the explosion is obtained. This combustion and explosion are also owing to the instantaneous evolution of elastic fluids. The potash unites with the sulphur and forms a sulphuret, which, with the assistance of the nitre, is converted into sulphurated hydrogen. At a certain temperature the sulphurated hydrogen gas is disengaged, along with the oxygen gas of the nitre, and suddenly taking fire, strikes the air by the explosion which accompanies the evolution of the gases. When the mixture is made with equal parts of nitre and solid sulphuret of potash, the detonation is

more rapid, but the explosion is less violent. With three parts of nitre, one of sulphur, and one of saw-dust, well mixed together, what is called powder of fusion is formed. If a little of this powder is put into a walnut-shell, with a thin plate of copper rolled up, and the mixture set fire to, it detonates rapidly, and reduces the metal to a sulphuret, without any injury to the shell.

POWER, in mechanics, denotes any force, whether of a man, a horse, a spring, the wind, water, &c. which being applied to a machine, tends to produce motion.

The intensity of a power is its absolute force; that is, its force, supposing its velocity equal to its weight: for its moving or acting force may be greater or less according as its velocity is increased or diminished, in respect of that of the weight. As for example, if a man be the power, and can raise from the ground a certain weight, that weight will express or be equal to the intensity of the power; for in this case, whatever engine be made use of, that part of the engine, where the weight is duly applied, will move just as fast as that on which a man acts with his whole force. A power may act in any direction whatever; but a weight has only one direction, *viz.* towards the centre of the earth.

When we speak of the mechanical powers, the word power is taken in a very different sense from that above laid down; since, in this case, it signifies only an organ or instrument, whereby a power of a known intensity is made to act upon a weight; and, therefore, we must take care not to attribute any real force to any simple or compound machine, as many are apt to do merely because the name power has been given to mechanical organs, not from their effect, but from the effect which the power produces by their means. For how much soever the force of a power is thereby increased, in order to sustain or raise a weight far superior to it in intensity; yet this cannot be done without losing in space and time what is gained in force; contrary to what some have vainly imagined, because the vulgar commonly speak of a machine as they do of an animal; attributing that effect to the machine, which is only the effect of the power by means of the machine: thus, it is usual to say, such a machine raises such a quantity of water, or performs such and such work; when we should say, if we would speak philosophically, such a running stream, such a fall of water, the wind, or so many men, horses, oxen, &c. raise so much water in such a time, &c. by means of such or such a machine. It were, therefore, to be wished that the word power were to be confined to its proper sense, and not used to signify one of the mechanical organs; however, as it has been customary to use it in that sense, we have done so too, but have nevertheless thought proper to give the above caution. See MECHANICS.

POWER *of attorney*, an instrument, or deed, whereby a person is authorised to act for another, either generally, or in a specific transaction.

This power is always revoked by the death of the grantor, and no person who has a power of attorney can grant a power under him.

POWERS, in arithmetic and algebra, are the products arising from the continual multiplication of a number, or quantity, into itself: thus, 2, 4, 8, 16, 32, &c. are the powers of the number 2; and a, a^2, a^3, a^4, &c. the powers of the quantity a; which operation is called involution. Powers of the same quantity are multiplied by only adding their exponents, and making their sum the exponent of the product: thus, $a^4 \times a^5 = a^{4+5} = a^9$. Again the rule for dividing powers of the same quantity, is to subtract the exponents, and make the difference the exponent of the quotient: thus, $\frac{a^6}{a^4} = a^{6-4} = a^2$.

Negative powers, as well as positive, are multiplied by adding, and divided by subtracting, their exponents, as above. And, in general, any positive power of a, multiplied by a negative power of a, of an equal exponent, gives unit for the product; for the positive and negative destroy each other, and the product is a^0, which is equal to unit. Likewise, $\frac{a^{-5}}{a^{-2}} = a^{-5+2} = a^{-3} = a^{\frac{1}{3}}$; and $\frac{a^{-2}}{a^{-5}} = a^{-2+5} = a^3 = \frac{1}{a^{-3}}$. And, in general, any quantity placed in the denominator of a fraction, may be transposed to the numerator, if the sign of its exponent be changed: thus, $\frac{1}{a^3} = a^{-3}$, and $\frac{1}{a^{-3}} = a^3$.

The quantity a^m expresses any power of a, in general; the exponent m being undetermined: and a^{-m} expresses $\frac{1}{a^m}$, or a negative power of a, of an equal exponent: and $a^m \times a^{-m} = a^{m-m} = a^0 = 1$. Again, a^n expresses any other power of a; and $a^m \times a^n = a^{m+n}$, and $\frac{a^m}{a^n} = a^{m-n}$.

To raise any simple quantity to its second, third, or fourth power, is to add its exponent twice, thrice, or four times to itself; so that the second power of any quantity is had by doubling its exponent; and the third, by tripling its exponent; and, in general, the power expressed by m, of any quantity, is had by multiplying the exponent by m: thus the second power, or square of a, is $a^{2 \times 1} = a^2$; its third power, $a^{3 \times 1} = a^3$; and the mth power of a, is $a^{m \times 1} = a^m$. Also the square of a^4, is $a^{2 \times 4} = a^8$; the cube of a^4, is $a^{3 \times 4} = a^{12}$; and the mth power of a^4, is $a^{4 \times m}$. The square of abc, is $a^2 b^2 c^2$; its cube $a^3 b^3 c^3$; and the mth power, $a^m b^m c^m$.

POX, or Small Pox. See Medicine.

PRACTICE, in arithmetic, or rules of practice, are certain compendious ways of working the rule of proportion, or golden-rule.

I. When a question in the rule of three being duly stated, and the extremes are simple numbers of one name; whether the middle term be simple or mixed; if the extreme, which by the general rule is the divisor, be 1, and the middle term, an aliquot part, of some superior species; then divide the other extreme by the denominator of that aliquot part, the quote is the answer in that superior species; and if there is any remainder, it must be reduced, and its value found. Example. What is the price of 67 yards of cloth at 5*s.* per yard? The state of the proportion is, as 1 yard : 5*s.* : : 67; and because the divisor is 1 yard and the middle term 5*s.* which is a fourth part of one pound. Therefore divide 67 yards by 4, the quote is 16*l.* and 3 remains, which reduced to shillings, and divided by 4, quotes 15*s.*

The reason of this practice is obvious; for if 1 yard cost one-fourth of 1*l.* 67 yards must cost 67¼th parts, or, which is the same thing, the fourth part of 67*l.*

II. If the price of an unit is an even number of shillings, multiply the other extreme (of the same name with the unit) by the half of that number; double the first figure of the product for shillings, and the remaining figures to the left, are pounds in the answer. Example. What is the value of 324 yards at 6*s.* per yard? Multiplying 324 by 3 (the one-half of 6) the product is 972, which according to the rule, is 97*l.* 4*s.* which is the answer. And it is very easy to set down the shillings and pounds separately, without writing first down the total product, and then separating them.

III. If the middle term is not an aliquot part of some superior integer, (the divisor being always 1), yet it may be equal to the sum of several aliquot parts; and then if you divide by the denominators of each of these separately, and add all the quotes, the same is the answer required. Example. If 1 yard cost 15*s.* what cost 49 yards? Answer 36*l.* 15*s.*: found thus; 15*s.* is 10*s.* and 5*s.* *viz.* the one-half and one-fourth of a 1*l.* so I take the one-half of 49*l.* which is 24*l.* 10*s.* and one fourth, which is 12*l.* 5*s.* whose sum is 36*l.* 15*s.*

IV. If the middle term is so mixed as to have in it any number of the highest species, first multiply the number, and then the other parts by some of the former cases, if possible, and if this cannot be done, or not without much working; then the common method of reduction is to be taken. Example. If 1 yard cost 4*l.* 6*s.* 8*d.* what cost 734 yards? Answer 3,180*l.* 15*s.* 4*d.* for 4*l.* multiplied by 734, produces 2,936*l.* and for 6*s.* 8*d.* which is the one-third of 1*l.* you must take the one-third of 734, which is 244*l.* 15*s.* 4*d.* and the sum of both is 3,180*l.* 13*s.* 4*d.*

V. If the extreme which is the multiplier is an aliquot part, or the sum of certain aliquot parts, of the unit, which is the divisor, then take by division such part or parts of the middle term (whether this be a simple, or mixed number) and if the multiplier has also some number of the same species with the unit, you must work for that number separately by some of the former cases, or the common rule; then add all the parts, which is the answer.

Example 1. If 1 pound weight cost 32*l.* what cost 4 ounces? Answer 8*l.* *viz.* one-fourth of 32*l.* because 4 ounces are one-fourth of 1 pound.

These are the chief and fundamental practices by aliquot parts, which, whoever understands, will easily find many particular abridgments depending upon the same principles.

PRÆCIPE, is the name of several writs in the English law, which are so called from the form of commanding the defendant to do the thing required.

PRÆMUNIRE, is a punishment inflicted upon him who denies the King's supremacy the second time; upon him who affirms the authority of the Pope, or refuses to take the oath of supremacy; upon such as are seditious talkers of the inheritance of the crown; and upon such as affirm that there is any obligation by any oath, covenant, or engagement whatsoever,

to endeavour a change of government either in church or state; or that both or either house of Parliament have or hath a legislative power without the King, &c. The judgment in præmunire at the suit of the King, against the defendant being in prison, is, that he shall be out of the King's protectection; that his lands and tenements, goods and chattels, shall be forfeited to the King; and that his body shall remain in prison at the King's pleasure; but if the defendant be condemned upon his default of not appearing, whether at the suit of the King or party, the same judgment shall be given as to the being out of the King's protection and the forfeiture; but instead of the clause that the body shall remain in prison, there shall be an award of a capiatur or arrest. Upon an indictment of a præmunire, a peer of the realm shall not be tried by his peers.

PRAGMATIC *sanction*, in the civil law, is defined by Hottoman to be a rescript, or answer of the sovereign, delivered by advice of his council, to some college, order, or body of people, upon consulting him on some case of their community. The like answer given to any particular person, is called simply rescript. The term pragmatic sanction, is chiefly applied to a settlement of Charles VI. Emperor of Germany, who, in the year 1722, having no sons, settled his hereditary dominions on his eldest daughter, the Archduchess Maria Theresa, which was confirmed by the diet of the Empire, and guaranteed by Great Britain, France, the States General, and most of the powers in Europe.

PRAM, or PRAME, a kind of lighter used in Holland and the ports in the Baltic Sea, to carry the cargo of a merchant ship along-side, in order to lade it, or to bring it to the shore to be lodged in warehouses. The same term is in use in military affairs, for a kind of floating battery, being a flat bottomed vessel, which draws little water, mounts several guns, and is exceedingly useful in transporting troops over the immense lakes in North America.

PRASIUM, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: berries four, one-seeded. There are two species, viz. P. majus, great Spanish hedge-nettle, and P. minus, small Spanish hedge-nettle.

PRAYER, in theology, a petition put up to God, either for the obtaining some future favour, or the returning of thanks for a past one.

PREBEND, the maintenance a prebendary receives out of the estate of a cathedral or collegiate church. Prebends are distinguished into simple and dignitary; a simple prebend has no more than the revenue for its support: but a prebend with dignity, has always a jurisdiction annexed to it.

PREBENDARY, an ecclesiastic who enjoys a prebend. The difference between a prebendary and a canon is, that the former receives his prebend, in consideration of his officiating in the church; but the latter merely by his being received into the cathedral or college.

PREBENDARY, *golden, of Hereford*, called also *prebendarius episcopus*, is one of the twenty-eight minor prebendaries, who has, *ex officio*, the first canon's place that falls. He was anciently confessor of the bishop and cathedral, and had the offerings at the altar; on which account he was called the golden prebendary.

PRECEDENCE, or PRECEDENCY, a place of honour to which a person is entitled: this is either of courtesy or of right. The former is that which is due to age, estate, &c. which is regulated by custom and civility: the latter is settled by authority, and when broken in upon gives an action at law.

The order of precedency, which is observed in general, is thus: that persons of every degree of honour or dignity take place according to the seniority of their creation, and not of years, unless they are descended from the blood-royal; in which case, they have place of all others of the same degree.

The younger sons of the preceding rank take place from the eldest son of the next mediate, viz. the younger sons of Dukes from the eldest sons of Earls; the younger sons of Earls from the eldest sons of Barons. All the chain of precedency is founded upon this gradation, and thus settled by act of parliament, 31 Henry VIII. c. 10, anno 1539.

But there have been since some alterations made in this act, by several decrees and establishments in the succeeding reigns, whereby all the sons of Viscounts and Barons are allowed to precede Baronets. And the eldest sons and daughters of Baronets have place given them before the

eldest sons and daughters of any Knights, of what degree or order soever, though superior to that of a Baronet; these being but temporary dignities, whereas that of Baronets is hereditary: and the younger sons of Baronets are to have place next after the eldest of Knights.

There are some great officers of state, who take place, although they are not noblemen, above the nobility of higher degrees; so there are some persons, who, for their dignities in the church, degrees in the universities, and inns of court, officers in the state, or army, although they are neither knights, nor gentlemen born, yet take place amongst them. Thus, all colonels and field-officers who are honourable, as also the master of the ordinance, quartermaster general, doctors of divinity, law, physic, and music; deans, chancellors, prebendaries, heads of colleges in universities, and serjeants at law, are, by courtesy, allowed place before ordinary Esquires. And all bachelors of divinity, law, physic, and music; masters of arts, barristers in the inns of courts; lieutenant-colonels, majors, captains, and other commissioned military officers; and divers patent officers in the King's household may equal, if not precede, any gentleman that has none of these qualifications.

In towns corporate, the inhabitants of cities are preferred to those of boroughs; and those who have borne magistracy to all others. And herein a younger alderman takes not precedency from his senior being knighted, or as being the elder Knight, as was the case of Alderman Craven, who, though no Knight, had place as senior alderman, before all the rest who were Knights, at the coronation of King James. This is to be understood as to public meetings relating to the town; for it is doubted whether it will hold good in any neutral place. It has been also determined in the Earl Marshal's court of honour, that all who have been Lord Mayors of London, shall every where take place of all Knights-bachelors, because they have been the King's lieutenants.

It is also quoted by Sir George Mackenzie, in his Observations on Precedency, that in the case of Sir John Crook, serjeant at law, it was adjudged by the judges in court, that such serjeants as were his seniors, though not knighted, should have preference notwithstanding his knighthood. The precedency among men is as follows:

The King Prince of Wales King's sons King's brothers King's uncles King's grandsons King's brothers or sisters grandsons Vicegerent — When there is any such officer Archbishop of Canterbury, Lord Primate of all England	by statute 34 Henry VIII.

Lord High Chancellor, or Lord Keeper, by statute 5 Elizabeth.

Archbishop of York, Primate of England, by statute 31 Henry VIII.

Lord High Treasurer Lord President of the Privy Council Lord Privy Seal	being of the degree of Barons by statute 31 Henry VIII.

By the statute 31 Henry VIII. the Lord Great Chamberlain of England had place next Lord Privy Seal; but in the year 1714, the Marquis of Lindsey, then Hereditary Lord Great Chamberlain of England, being created Duke of Ancaster, &c. gave up the precedency as Lord Great Chamberlain from him and his heirs, except only when he or they shall be in the actual execution of the said office of Great Chamberlain of England, attending the person of the King or Queen for the time being, or introducing a Peer or Peers into the House of Lords, which was confirmed by statute 1 George I.

Lord High Constable Earl Marshal Lord High Admiral Lord Steward of his Majesty's Household Lord Chamberlain of his Majesty's Household	above all of their degrees, *viz.* if Dukes, above Dukes; if Earls, above Earls, &c. by statute 31 Henry VIII.

Dukes according to their patents of creation Marquisses according to their patents Dukes eldest sons Earls according to their patents Marquisses eldest sons Dukes younger sons Viscounts according to their patents Earls eldest sons Marquisses younger sons Bishop of London Bishop of Durham Bishop of Winchester	By stat. 31 of Hen. VIII.

All other Bishops, according to their seniority of consecration; but if any Bishop be principal Secretary of State, he shall be placed above all other Bishops, not having any of the great offices before-mentioned.

Barons according to their patents.

But if any Baron be principal Secretary of State, he shall be placed above all Barons, unless they have any of the before-mentioned great offices.

By stat. of 31 Hen. VIII.

By the 23d article of the Union, which was confirmed by statute of 5 Queen Anne, c. 8, all Peers of Scotland shall be Peers of Great Britain, and have rank next after the Peers of the like degree in England at the time of the Union, which commenced May 1, 1707, and before all Peers of Great Britain, of the like degree, created after the Union.

Speaker of the Hon. House of Commons.
Viscounts eldest sons.
Earls younger sons
Barons eldest sons.
Knights of the most noble order of the Garter.
Privy Counsellors.
Chancellor of the Exchequer.
Chancellor of the duchy of Lancaster.

The Peers of Ireland take place in England, at all public ceremonies, (except coronations) next the youngest English peer of the same degree.—Vide 1, 25, p. 61, in Officio Armorum Council Books, 4 Car. I. 28 June, 1629.

Lord Chief Justice of the King's Bench.
Master of the Rolls.
Lord Chief Justice of the Common Pleas.
Lord Chief Baron of the Exchequer.
Judges and Barons of the degree of the Coif of the said Courts, according to seniority.
Bannerets made under the King's own royal standard, displayed in army royal in open war, by the King himself in person, for the term of their lives only, and no longer.
Viscounts younger sons.
Barons younger sons.
Baronets of England, Scotland, and Ireland.
Bannerets not made by the King himself in person.

Rot. Pat. X. Jac. I. Parl. X. n. VIII.

Knights of the most honourable Order of the Bath.
Flag and field officers.

The priority of signing any treaty, or public instrument, by public Ministers, is always taken by rank of place, and not by title.

Knights Bachelors.
Masters in Chancery.
Doctors, Deans, &c.
Serjeants at Law.
Eldest sons of the younger sons of Peers.
Baronets eldest sons.
Knights of the Garter eldest sons.
Bannerets eldest sons.
Knights of the Bath eldest sons
Knights eldest sons.

Vide infra for the younger sons.

Baronets younger sons, Rot. Pat. 14 Jac. ibid.
Esquires of the Sovereign's body or Gentlemen of the Privy Chamber. by stat. 20 Ed. IV. and 9 Hen. VI.
Esquires of the Knights of the Bath.
Esquires by creation, by stat. 20 Edw. IV. and 9 Hen. VI.
Esquires by office.
Younger sons of Knights of the Garter.
Younger sons of Bannerets of both kinds.
Younger sons of Knights of the Bath.
Younger sons of Knights Bachelors.

Estab. by H. VI. & E. IV. &c. Vincent's Precedence, 151, folio 124.

Gentlemen entitled to bear arms.
Clergymen, Barristers at law; Officers in the Navy and Army, who are all Gentlemen by profession.
Citizens.
Burgesses, &c.

Almost every person above the lowest rank of mechanics assuming the title of Esquire, it may be worth while to give our readers the opinion of Judge Blackstone on this subject. Esquires and gentlemen are confounded together by Sir Edward Coke, who observes, that every esquire is a gentleman, and a gentleman is defined to be one *qui arma gerit*, who bears coat armour, the grant of which adds gentility to a man's family: in like manner as civil nobility among the Romans was founded in the *jus imaginum*, or having the image of one ancestor at least, who had borne some curule office. It is indeed a matter somewhat unsettled, what constitutes the distinction, or who is a real esquire; for it is not an estate, however large, that confers this rank upon its owner. Camden, who was himself a herald, distinguishes them the most accurately, and he reckons up four sorts of them: 1. The eldest sons of Knights, and

their eldest sons, in perpetual succession. 2. The eldest sons of younger sons of Peers, and their eldest sons, in like perpetual succession: both which species of esquires Sir Henry Spelman entitles *armigeri natalitii.* 3. Esquires created by the King's letters patent, or other investiture, and their eldest sons. 4. Esquires by virtue of their offices, as justices of the peace, and others who bear any office of trust under the crown. To these may be added the esquires of Knights of the Bath, each of whom constitutes three at his installation; and all foreign, nay, Irish Peers: for not only these, but the eldest sons of Peers of Great Britain, though frequently titular lords, are only esquires in the law, and must be so named in all legal proceedings. As for gentlemen, says Sir Thomas Smith, they be made good cheap in this kingdom; for whosoever studieth in the Universities, who professeth the liberal sciences, and (to be short) who can live idly, and without manual labour, and will bear the port, charge, and countenance of a gentleman, he shall be called master, and shall be taken for a gentleman. A yeoman is he that hath free land of forty shillings by the year; who was anciently thereby qualified to serve on juries, vote for knights of the shire, and do any other act, where the law requires one that is *probus et legalis homo.* The rest of the commonalty are tradesmen, artificers, and labourers, who (as well as all others) must, in pursuance of the statute 1 Henry V. c. 5. be styled by the name and addition of their estate, degree, or mystery, and the place to which they belong, or where they have been conversant, in all original writs of actions personal, appeals, and indictments, upon which process of outlawry may be awarded; in order, as it should seem, to prevent any clandestine or mistaken outlawry, by reducing to a specific certainty the person who is the object of its process.

The precedency among men being known, that which is due to women, according to their several degrees, will be easily understood: but it is to be observed, that women, before marriage, have precedency by their father: with this difference between them and the male children, that the same precedency is due to all the daughters that belongs to the eldest, which is not so among the sons; and the reason of this disparity seems to be, that daughters all succeed equally, whereas the eldest son excludes all the rest.

By marriage, a woman participates of her husband's dignities; but none of the wife's dignities can come by marriage to her husband, but are to descend to her next heir.

If a woman have precedency by creation or birth, she retains the same though she marry any commoner; but if a woman nobly born marry any Peer, she shall take place according to the degree of her husband only, though she be a Duke's daughter.

A woman privileged by marriage with one of noble degree, shall retain the privilege due to her by her husband, though he should be degraded by forfeiture, &c. for crimes are personal.

The wife of the eldest son of any degree takes place of the daughters of the same degree, who always have place immediately after the wives of such eldest sons, and both of them take place of the younger sons of the preceding degree. Thus, the lady of the eldest son of an Earl takes place of an Earl's daughter, and both of them precede the wife of the younger son of a Marquis; also the wife of any degree precedes the wife of the eldest son of the preceding degree. Thus, the wife of a Marquis precedes the wife of the eldest son of a Duke.

The Queen.
Princess of Wales.
Princesses, and Duchesses of the Blood.
Duchesses.
Wives of the eldest sons; daughters, } of Dukes of the Blood.
Marchionesses.
Wives of the eldest sons; daughters, } of Dukes.
Countesses.
Wives of the eldest sons; daughters, } of Marquisses.
Wives of the younger sons of Dukes.
Viscountesses.
Wives of the eldest sons; daughters, } of Earls.
Wives of the younger sons of Marquisses.
Baronesses.
Wives of the eldest sons; daughters, } of Viscounts.
Wives of the younger sons of Earls.
Wives of the eldest sons; daughters, } of Barons.
Wives of the younger sons of Viscounts.
Wives of the younger sons of Barons.
Wives of Baronets.
Wives of Knights of the Garter.
Wives of Knights of the Bath.
Wives of Knights-Bachelors.

Wives of the eldest sons; daughters,	of Baronets.
Wives of the eldest sons; daughters,	of Knights of the Garter.
Wives of the eldest sons; daughters,	of Knights of the Bath.
Wives of the eldest sons; daughters,	of Knights-Bachelors.

Wives of the youngest sons of Baronets.
Wives of Esquires, by creation.
Wives of Esquires, by office.
Wives of Gentlemen.
Daughters of Esquires.
Daughters of Gentlemen.
Wives of Citizens.
Wives of Burgesses, &c.

The wives of Privy Counsellors, Judges, &c. are to take the same place as their husbands do. See the former list.

PRECENTOR, a dignitary in cathedrals, popularly called the chantor, or master of the choir.

PRECESSION *of the equinoxes*, is a very slow motion of them, by which they change their place, going from east to west, or backward, *in antecedentia*, as astronomers call it, or contrary to the order of the signs.

From the late improvements in astronomy it appears, that the pole, the solstices, the equinoxes, and all the other points of the ecliptic, have a retrograde motion, and are constantly moving from east to west, or from Aries towards Pisces, &c. by means of which, the equinoctial points are carried further and further back among the preceding signs or stars, at the rate of about 50″½ each year; which retrograde motion is called the precession, recession, or retrocession of the equinoxes.

Hence, as the stars remain immoveable, and the equinoxes go backward, the stars will seem to move more and more eastward with respect to them; for which reason the longitudes of all the stars, being reckoned from the first point of Aries, or the vernal equinox, are continually increasing.

From this cause it is, that the constellations seem all to have changed the places assigned to them by the ancient astronomers. In the time of Hipparchus, and the oldest astronomers, the equinoctial points were fixed to the first stars of Aries and Libra: but the signs do not now answer to the same points; and the stars which were then in conjunction with the sun, when he was in the equinox, are now a whole sign, or 30 degrees, to the eastward of it: so, the first star of Aries is now in the portion of the ecliptic, called Taurus; and the stars of Taurus are now in Gemini; and those of Gemini in Cancer; and so on.

This seeming change of place in the stars was first observed by Hipparchus of Rhodes, who, 128 years before Christ, found that the longitudes of the stars in his time were greater than they had been before, observed by Tymochares, and than they were in the sphere of Eudoxus, who wrote 380 years before Christ. Ptolemy also perceived the gradual change in the longitudes of the stars; but he stated the quantity at too little, making it but 1° in 100 years, which is at the rate of only 36″ per year. Y-hang, a Chinese, in the year 721, stated the quantity of this change at 1° in 83 years, which is at the rate of 43″½ per year. Other more modern astronomers have made this precession still more, but with some small differences from each other; and it is now usually taken at 50″½ per year. All these rates are deduced from a comparison of the longitude of certain stars, as observed by more ancient astronomers, with the later observations of the same stars; viz. by subtracting the former from the latter, and dividing the remainder by the number of years in the interval between the dates of the observations. Thus, by a medium of a great number of comparisons, the quantity of the annual change has been fixed at 50″½, according to which rate it will require 25,791 years for the equinoxes to make their revolutions westward quite around the circle, and return to the same point again.

The phenomena of this retrograde motion of the equinoxes, or intersections of the equinoctial with the ecliptic, and consequently of the conical motion of the earth's axis, by which the pole of the equator describes a small circle in the same period of time, may be understood and illustrated as follows; Let NZSVL be the earth. (See Plate Perspective, &c. fig. 6.) SONA its axis produced to the starry heavens, and terminating in A, the present north pole of the heavens, which is vertical to N, the north pole of the earth. Let EOQ be the equator, T♋Z the tropic of cancer, and VT♑ the tropic of capricorn; VOZ the ecliptic, and BO its axis, both of which are immoveable among the stars. But as the equinoctial points recede in the ecliptic, the earth's axis SON is in motion upon the earth's centre O, in such a manner as to describe the double cone NO*n* and SO*s*, round the axis of the ecliptic BO, in the time that the equinoctial points move round

the ecliptic, which is 25,791 years; and in that length of time, the north pole of the earth's axis produced, describes the circle ABCDA in the starry heavens, round the pole of the ecliptic, which keeps immoveable in the centre of that circle. The earth's axis being now 23° 28′ inclined to the axis of the ecliptic, the circle ABCDA, described by the north pole of the earth's axis produced to A, is 46° 56′ in diameter, or double the inclination of the earth's axis. In consequence of this, the point A, which is at present the north pole of the heavens, and near to a star of the 2d magnitude in the end of the Little Bear's tail, must be deserted by the earth's axis; which moving backwards one degree every 71¾ years nearly, will be directed towards the star or point B in 6447¾ years hence; and in double of that time, or 12,895½ years, it will be directed towards the star or point C; which will then be the north pole of the heavens, although it is at present 8¼ degrees south of the zenith of London L. The present position of the equator EOQ will then be changed into *eOq*, the tropic of cancer T♋Z into V*t*♋, and the tropic of capricorn VT♑ into *t*V♑Z; as is evident by the figure. And the sun, in the same part of the heavens where he is now over the earthly tropic of capricorn, and makes the shortest days and longest nights in the northern hemisphere, will then be over the earthly tropic of cancer, and make the days longest and nights shortest. So that it will require 12,895½ years yet more, or from that time, to bring the north pole N quite round, so as to be directed towards that point of the heavens which is vertical to it at present. And then, and not till then, the same stars which at present describe the equator, tropics, and polar circles, &c. by the earth's diurnal motion, will describe them over again.

From this shifting of the equinoctial points, and with them all the signs of the ecliptic, it follows, that those stars, which in the infancy of astronomy were in Aries, are now found in Taurus; those of Taurus in Gemini, &c. Hence likewise it is, that the stars which rose or set at any particular season of the year, in the times of Hesiod, Eudoxus, Virgil, Pliny, &c. by no means answer at this time to their descriptions.

As to the physical cause of the precession of the equinoxes, Sir Isaac Newton demonstrates, that it arises from the broad or flat spheroidal figure of the earth; which itself arises from the earth's rotation about its axis: for as more matter has thus been accumulated all round the equatorial parts than any where else on the earth, the sun and moon, when on either side of the equator, by attracting this redundant matter, bring the equator sooner under them, in every return towards it, than if there was no such accumulation.

Sir Isaac Newton, in determining the quantity of the annual precession from the theory of gravity, on supposition that the equatorial diameter of the earth is to the polar diameter, as 230 to 229, finds the sun's action sufficient to produce a precession of 9″¼ only; and collecting from the tides the proportion between the sun's force and the moon's, to be as 1 to 4½, he settles the mean precession resulting from their joint actions at 50″; which is nearly the same as it has since been found by the best observations.

PRECIÆ, in botany, the name of the twenty-first order in Linnæus's Fragmenta of a Natural Method; containing the primrose, and a few other plants which agree with it in habit and structure.

PRECIPITATE, in chemistry, is any matter or substance, which having been dissolved in a fluid, falls to the bottom of the vessel on the addition of some other substance, capable of producing a decomposition of the compound. The term is generally applied when the separation takes place in a flocculent or pulverulent form, in opposition to crystallization, which implies a like separation in an angular form. But chemists call a mass of crystals a *precipitate*, when they subside so suddenly, that their proper crystalline shape cannot be distinguished by the naked eye, as in the instance of Glauber's salt, when separated from its watery solution by mixing with it a portion of alcohol.

PRECIPITATION, that process by which bodies dissolved, mixed, or suspended in a fluid, are separated from the fluid, and made to gravitate to the bottom of the vessel: this is one of the great operations in chemistry, and is opposed to that of solution. In truth the chief operations in the laboratory may be resolved into solution and precipitation. When a base is employed to precipitate a soluble acid, the substance thrown down is always a compound, consisting of the acid united to the base employed. In this case the acid is sometimes completely separated, and sometimes not, according to the energy of the base employed, and the degree of insolubility of the salt formed. The same explanation

applies as in the first case. When a neutral salt is employed as a precipitant, the substance which falls is always a compound. It is composed of one of the ingredients of the precipitating salt united to one ingredient of salt in solution. Such salts alone can be employed as are known to form insoluble compounds with the acid or base which we wish to throw down. In these cases the separation is complete, when the new salt formed is completely insoluble. Neutral salts perform the office of precipitants in general much more readily and completely than pure bases or acids. Thus the alkaline carbonates throw down the earths much more effectually than the pure alkalies, and sulphate of soda separates barytes much more rapidly than pure sulphuric acid. This superiority is owing partly to the combined action of the acid and base, and partly to the comparatively weak action of a neutral salt upon the precipitate, when compared to that of an acid or alkali. For the precipitation takes place, not because the salts are insoluble in water, but because they are insoluble in the particular solution in which the precipitate appears. Now if this solution happens to be capable of dissolving any particular salt, that salt will not precipitate, even though it be insoluble in water. Hence the reason why precipitates so often disappear, when there is present in the solution an excess of acid, of alkali, &c.

PRECONTRACT *of marriage*, in the civil law, avoided the marriage; but by the statute 2 George I. c. 23, called the marriage act, it is declared, that it shall not be allowed, nor shall any contract of marriage be enforced in the ecclesiastical courts. The only remedy upon breach of a promise of marriage is by action for damages at common law.

PREDIAL *tithes*, those which are paid of things arising and growing from the ground only, as corn, hay, fruit of trees, and the like.

PREENING, in natural history, the action of birds dressing their feathers, to enable them to glide the more readily through the air, &c. For this purpose they have two peculiar glands on their rump, which secrete an unctuous matter into a bag that is perforated, out of which the bird occasionally draws it with its bill.

PREGNANCY. See MIDWIFERY.

PREHNITE, in mineralogy, a species of the flint genus. Its colours are green in almost all its shades. It is sometimes massive, sometimes crystallized. Externally the crystals are smooth and shining; internally they have a glistening pearly lustre. It is harder than glass, easily frangible: specific gravity 2.6 to 2.9. Before the blowpipe it foams, and melts into a brownish enamel. This mineral has been compared with the zeolite, to which it bears some resemblance; but it does not, like that, become gelatinous with acids. According to Klaproth it consists of

Silica	43.83
Alumina	30.33
Lime	18.33
Oxide of iron	5.66
Water	1.83
	99.98
Loss	2
	100.00

It occurs in Dauphiny, and in many parts of Scotland.

PRELIMINARY, in general, denotes something to be examined and determined before an affair can be treated of to the purpose. The preliminaries of peace consist chiefly in settling the powers of ambassadors, and certain points in dispute, which must be determined previously to the treaty itself.

PRELUDE, *præludium*, in music, is usually a flourish or irregular air, which a musician plays off-hand, to try if his instrument be in tune, and so lead him into the piece to be played. Very often the whole band in the orchestra run a few divisions, to give the tune.

PREMISES, in logic, an appellation given to the two first propositions of a syllogism, as going before, or preceding the conclusion. Premises are the foundation or principles of our reasoning; which being either self-evident or demonstrative propositions, the truth of the conclusion is equally evident.

PREMISES, in law, from the Latin *premissa* (the foregoing), is applied to that part in the beginning of a deed which expresses the names of the grantor and grantee, and the land or thing granted; but it is chiefly used to signify the thing granted only.

PREMIUM, or PRÆMIUM, properly signifies a reward or recompense; but it is chiefly used in a mercantile sense for the sum of money given to an insurer, whether of ships, houses, lives, &c. See INSURANCE. The term premium is also applied to what is given for a thing above par, or prime

cost: thus if lottery tickets sell for 20s. more than prime cost, or the price at which the government issued them, this 20s. is called a premium.

PREMNA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx two-lobed; corolla four-cleft; berry four-celled; seeds solitary. There are two species; *viz.* P. integrefolia, and P. serratifolia; both natives of the East Indies.

PRENANTHES, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx calycled; florets in a single row; pappus simple, subsessile; receptacle naked. There are nineteen species.

PREPOSITION, in grammar, one of the parts of speech, being an indeclinable particle, which yet serves to govern the nouns that follow it. See GRAMMAR.

PREPUCE. See ANATOMY.

PREROGATIVE, in law, means all the rights and privileges which by law the King hath, as chief of the commonwealth, and as intrusted with the execution of the laws; and this can be only according to Magna Charta. We shall here briefly set down those articles which are enumerated by Lord Chief Baron Comyns, in his "Digest," as belonging to the King's prerogative, premising only, that many things are laid down in our law-books from ancient authorities, which do not thoroughly accord with the spirit of the constitution, as improved at the revolution; and that every thing which is contrary to that glorious spirit, may be well questioned to be law at the present day. Those who were formerly called prerogative lawyers, were little better than the willing slaves of absolute monarchy.

As to his domestic concerns, the care of the marriages in the royal family belongs to the King, and is now regulated by statute 12 George III., c. 11.

As to foreign nations, he has the sovereignty of the seas surrounding England, and may make treaties and alliances, and send ambassadors and envoys to foreign states, and a league is said to be broken by a prohibition of all the commodities of a kingdom in amity. He may, in virtue of the same right, grant reprisals, by taking the goods of foreign subjects, here or elsewhere, and he is entitled to all prizes; but, by certain acts called the prize-acts, they are distributed in certain shares amongst the captors, according to a proclamation to be made in every new war, and 5*l.* a head is allowed to ships of war for every man killed. The King may also grant letters of safe conduct to an enemy here; and without these, it is said, a foreign prince, though in amity, cannot come here.

With respect to the King's own subjects, he has the sole authority to declare war or peace, and to levy soldiers, and by 11 Henry VII. c. 1 and 18, every man is bound to serve the King in his wars, but not out out of the realm, except for wages; nor can he be sent out of the kingdom even with an office. In like manner, the right of impressing seamen is acknowledged; but it must not be exercised wantonly, as by taking a captain of a merchantman to serve as a common man, and, by 13 George II. c. 17, persons of fifty-five years of age, and under eighteen, and every person going to sea for two years, and every apprentice during three years, are exempted; and also all foreigners; besides which there are other particular exemptions; nor are mariners, except deserters, to be impressed in the West Indies. He has also the sole command of the forces, as well militia as regulars, and that, by 13 Charles II. c. 6, independent of the Houses of Parliament. His troops may be billeted all over the kingdom; and no one but the King can build forts.

With respect to time of peace, he enacts laws, together with his Parliament; but cannot by grant or charter alter the law. He may issue proclamations to enforce laws; and, by 1 James, c. 25, and 12 Charles II. 4, s. 12, may restrain the transportation of corn, and gunpowder, arms, and ammunition, generally, or from particular places. By statute 31 Henry VIII. since repealed, he might, in effect, make new laws by his proclamation. But now he cannot suspend the execution of a law for any time, as till the meeting of the next Parliament. It is said, that the King may dispense with a thing prohibited, so as to make it lawful, in case of necessity, to the party to do the prohibited thing; but dispensations are odious, and, indeed, except under the following limitations, the King's dispensing power may now be questioned. As, however, he may grant a pardon when the offence is committed, it seems not of so much importance. He may unquestionably dispense with any thing which is for his benefit, as a penalty due to the King; but not with a thing *malum in se*,

nor in which the subject has an interest. He may grant a pardon of all offences, as well in the ecclesiastical as the criminal court; but cannot reverse a judgment without process.

With respect to things ecclesiastical, he has jurisdiction in all ecclesiastical causes, is head of the church, and may punish and repress heresies and superstitions, by statute 37 Henry VIII. c. 17. And ecclesiastical laws, which consist of ancient synods, and canons, and constitutions, and customs, formed with the assent of the King, without the Parliament, are of legal authority in England, and, it is said, he may dispense with those laws. He may, with his commissioners pass ecclesiastical censure, and shall have the ordering of all ecclesiastical appeals, without appeal to the Pope. The highest appeal, by statute 25 Henry VIII. c. 19, is to the King, in Chancery, who issues a commission to his delegates; but where the King is concerned, it is to the Upper House of Convocation; and although the appeal to the delegates is final, yet the King may grant a commission of review.

The King's prerogative, as to temporal jurisdiction, enables him to make what courts he pleases, for the administration of the common law, and where he pleases; but he cannot erect a court of Chancery, or Conscience, the common law being the birth-right of the subject. The King may also grant such commissions as are warranted or allowed by the common or statute law, as of oyer and terminer, &c.; but, it is said, he cannot grant a commission of inquiry only, without a clause to hear and determine. He may grant franchises also, because all franchises and liberties are derived from him, as a county palatine, or jurisdiction temporal, or ecclesiastical.

As to nobility and honour, the King is the fountain of all dignity, and may, it is said, compel all persons of 20*l.* per annum inheritance, to be knights, or persons named to be serjeants, to take the degree.

The King may also grant privileges, such as those of a forest, chase, warren, park, fair, market, with tolls, or casual profits, as wreck, waifs, strays, deodands, treasure-trove, royal fish, mines, derelict lands, most of which belong to the King, together with certain privileges in trade, for which see TRADE. So he may grant exemptions from those charges which, by his grant, he may impose, as to be quit of toll for merchandise, in every town in England, and to be exempt from offices under the crown, such as that of constable, provided there be a sufficient number to serve; but he cannot grant an exemption from the jurisdiction of any court, if he does not erect a jurisdiction of the same nature in lieu of it, for that would create a failure of justice; nor to be exempt from punishment from felony or trespass. He may also by proclamation or special writ, directed to the party, or to the sheriff, restrain any person from quitting the kingdom, and may, for reasons of state, lay an embargo upon a ship. So he may inhibit a public nuisance. He may also recal, by summons, a subject who goes out of the kingdom with or without licence, and if he returns not, upon service of summons, then his lands and goods are forfeited. But, it is said, merchants may abide beyond sea, and a King, in amity, need not deliver up those who fly to him.

The King may, by his prerogative, command mayors and corporate officers to restrain annoyances, and keep streets clean; but not in places which are no corporations; and cannot inhibit a lawful occupation, such as making cards, under pretence of inconvenience, nor restrain the exercise of foot-ball, cock fighting, or other vain sports, except, perhaps, on Sundays.

As to offices, the King has the nomination of all public officers within the kingdom; but he cannot create a new office with a fee, nor appoint an old office with a new fee, to burthen the public, without his Parliament.

As to trade, he may erect societies for the management of it; but cannot grant an embargo on ships, for the benefit of a private trader or company.

As to matters of revenue, the King can alone coin money within his dominions, upon which the duties are now settled, as in statute 18 Charles II.; but the aid, for knighthood, marriage, &c. are taken away by statute 12 Charles II. c. 24.

With respect to purveyance, he may dig for saltpetre in the lands, stables, and other places of a subject; but not where he cannot leave the place in the same plight as before. He must leave room for the horses, &c. of the person, and not dig at improper times, nor return there for a long time, nor can he grant it to another, and the saltpetre must be used for the defence of the realm only, and the subject is at liberty still to dig in his own soil. But he cannot claim any other necessaries, such as timber, wood, fuel, cattle, grain, hay, victuals, carts, carriages, &c. without the consent

of the owner, by statute 12 Charles II. c. 24.

The customs upon merchandise exported and imported, are the ancient inheritance of the crown, which, it is said, were originally by act of Parliament; they were distinguished into *custuma magna*, *et parva*, to which were added prisage, or a duty of two tons out of every ship laden with twenty tons of wine; and butlerage, or a levy of 2*s*. per ton, for every ton of wine of a merchant stranger. The citizens of London were exempt from this duty in the port of London. These duties, it seems, are now repealed by statute 27 George III. c. 13, called the Consolidation act, which affixes a certain rate to the commodities therein enumerated, and 27*l*. 10*s*. per cent, with a drawback of 25*l*. per cent., on exportation, upon every other commodity. We have, however, read in the public prints during this year, (1807) of the claim of prisage being made in Ireland, by one of the grantees of the crown, and allowed; but we presume, so heavy a tax, if it can be claimed, in addition to the duty on wines, must be repealed by Parliament. Customs are not paid where the King has granted goods of a pirate to a patentee, for the King shall not pay custom to himself; and it is said, the King may grant to an alien to pay no more customs than a subject; but this must be subject to the Consolidation act.

The King may, by his prerogative, charge an imposition upon the subject for his benefit, as he may grant a certain rate for things sold in a town, for the walls of the town, or repairing the bridge, or the security of those parts. Or that a man may build a wall, or keep a ferry, and take toll for the support of it. But he cannot charge the subject where he has no benefit from it, or a *quid pro quo*, nor levy new customs, &c. Nor can the merchants, by their consent, grant to the King a tax upon their goods, for their wares would thereby be sold the dearer. Upon all which we must observe that it should appear this branch of the prerogative is fallen into disuse, and can scarcely now be claimed as being altogether inconsistent with the spirit of the revolution in 1688. And we now see that in all cases where a pier is to be built, or a turnpike-road made, or improvements are made in cities, application is had to Parliament, and a bill is passed. This, it is true, may be partly, because it is often necessary, to borrow large sums of money, and to purchase lands by compulsion, &c.; but we still may venture to question this prerogative, although we find it in books of great authority previously to the reigns of Charles the First and Second.

As to casual profits, the King is entitled to all goods which have no owner, as wreck, flotsan, jetsan, and ligan, waifs, strays, goods of felons, deodands, treasure-troves, escheats, and lands forfeited. He is entitled also to royal mines, and the fishery of every navigable river, as high as the sea flows: but every one may fish in the sea of a common-right, although foreign nations cannot fish in the British Seas without the King's licence. There are also certain fines, upon legal proceedings, which the King claims by his prerogative; and anciently, a fine was paid for liberty to have right and justice, which is now abolished by Magna Charta 29, *nulli vendemus*, &c. So fines for beau pleader, for grants of liberties, and for misdemeanors, with all amerciaments which are levied by the Sheriff and estreated into the Exchequer.

All the lands in the kingdom, it is said, are holden mediately, or immediately, of the King, who has no superior; and this is the foundation of the law of forfeiture and escheats: but this, however in practice it may be harmless, is a principle rather derived from the divine right of kings, than the spirit of the revolution, which considers the King rather as deriving every thing from the people, and holding the throne itself in trust.

Whatsoever lands, or tenements, the King has, belong to him in right of his crown, and are called the sacred patrimony, or demesnes of the crown, says Lord Coke; and whether lands descend, or are devised, or given to him and his heirs by statute, or otherwise, they go as parcel of the crown. The King, therefore, it seems, cannot divest himself of his public character, but has all his real possessions, for it does not seem to extend to money, merely as king.

All conveyances to the King ought to be, by deed, enrolled; and where a subject would not have possession without entry, there the King has it not without office found, or other record. But if the King's title is so found upon an inquisition, he is in possession without seisure; and where a common person cannot enter without an action, there the King ought to have a *seire facias*. But no office is necessary where the King's title appears by other matter of record, and where he is so seised he can never be ejected, or disseised; but every one who enters upon his possessions is call-

ed an intruder; the remedy upon which is by an information of intrusion. The remedy against the King is by petition to the King in Parliament, in Chancery, or some other court, for there can be no writ, because the King cannot command himself, as it is quaintly expressed. There is also another proceeding by *monstrance de droit*, which is, where the suitor's title appears by the same record as that of the King. Even upon an office found there may now be, by statute 34 Edward III. c. 14, a traverse, denial, or litigation, of it.

The King, by his prerogative, may sue in what court he pleases, and shall not be prejudiced by any neglect to pursue his right, which is meant by the maxim *nullum tempus*, &c. or no time runs against the King. Though now, by statute 9 George III. c. 16, the King's suit, except for liberties and franchises, is limited, under certain conditions, to 60 years for lands.

As to the disposal of the personal revenue of the King, this can only be by the Great, or Privy Seal; and every one who receives money out of the Exchequer, without due warrant, is accountable for it. He may, it is said, dispose of his lands and other real revenues of inheritance, by patent, to others, when he pleases. And by statute 1 Anne 7, s. 5, all grants by the King of any manors, lands, &c. advowsons of churches and vicarages excepted, shall be void, except for 31 years or under, or for 3 lives, &c. subject to waste, and at the usual rent or more, or if no usual rent, then a rent at least one-third of the annual value. By the same act, the hereditary excise, revenue of the post-office, first fruits and tenths, fines for writs of covenant, and entry at the alienation office, post fines, wine licences, sheriffs profers, and compositions, and seisures for unaccustomed and prohibited goods, shall not be alienable for longer than the life of the King who grants them.

It is to be observed that much of the King's prerogative, producing revenue, has been from time to time granted out with various manors, and the article of forfeitures, which might in some cases be somewhat profitable, is very little enforced. When a forfeiture is discovered, the officers of the crown generally allow a portion to the informer; sometimes one-sixth. It has been proposed, by Mr. Bentham, to make forfeitures of land supply, in some measure, the place of taxes, and to restrain the power of bequest of land to certain degrees of kindred only. Blackstone and others, however, though they approve of the statute of Anne to prevent the improperly granting away crown lands, consider the great diminution of the landed demesnes of the crown well exchanged by the subject for the lighter burthen of taxes, since, had things remained as at the conquest, the King would, by forfeiture and otherwise, have possessed all the land in the kingdom. The observation is short-sighted enough, for no people would have tolerated it. William possessed all the lands by force, only to parcel them out like a robber among his troops, and had he not speedily parted with them, he and they must have found that he who grasps all loses all. See REVENUE.

PREROGATIVE *court*, the court wherein all wills are proved, and all administrations taken, which belong to the Archbishop by his prerogative; that is, in cases where the deceased had goods of any considerable value out of the diocese wherein he died; and that value is ordinarily 5*l.* except it be otherwise, by composition, between the Archbishop and some other Bishop, as in the diocese of London, it is 10*l.*

PRESBYTERIANS. This denomination of Protestant Dissenters has been called by different names at different periods of time. In their first attempts for a further reformation of the church, they were, by way of reproach, termed Puritans, a name derived from the *Cathari* or *Puritani* of the third century. But reproachful names have not been the only species of persecution they have at various times suffered. The cruel persecutions they suffered in the reigns of Elizabeth, James I. and the two Charleses, will ever reflect disgrace upon the memory of those princes.

The reformed exiles who were driven to Franckfort, to avoid the cruelties of Mary I. and who afterwards set up congregations at Basil and Geneva, were first called Puritans, as their opponents obtained the name of Conformists. From the Puritans sprung the Presbyterians, whose form of church discipline was first established and is still followed by the Kirk of Scotland. The first Presbyterian church in England was erected at Wandsworth, a village near London; and, on the 20th of November, 1572, eleven elders were chosen, and their offices described in a register, entitled The Order of Wandsworth. Other churches, notwithstanding proclamations for uniformity, &c. were soon erected in other counties, though with the utmost privacy and secrecy. But we are compelled by our limits to omit many important particulars

in the history of the Presbyterians, during the periods of their alternate sufferings and triumphs. Their history, like that of other numerous and powerful bodies of men, exhibits a melancholy picture of the instability of the human mind, and the evil tendency of religious prejudice, when combined with human power and authority. For who could have thought, that the very men, who had suffered every species of privation, who had been exiled for conscience sake, who had borne the most cruel persecutions at home, and the contumely of the Lutherans abroad, with the courage and the constancy of martyrs, that these very men, when armed by the same species of power that before had well nigh crushed them to atoms, should themselves imbibe the principles and follow the practices of their most cruel persecutors? It is hardly credible, but it is nevertheless a melancholy fact, that an Ordinance against blasphemy and heresy was passed in May, 1648, by the influence of the Presbyterians then in parliament, in which it was decreed, "that all persons who shall willingly maintain, publish, or defend, by preaching or writing,"—"that the Father is not God, that the Son is not God, that the Holy Ghost is not God; or that these three are not one eternal God; or, that Christ is not God equal with the Father,"—"shall upon complaint or proof, by oath of two witnesses, before two justices of the peace, be committed to prison, without bail or mainprize, till the next goal-delivery; and in case the indictment shall then be found, and the party upon his trial shall not abjure the said error, and his defence and maintenance of the same, he shall suffer the pains of death, as in case of felony, without benefit of clergy; and if he recant or abjure, he shall remain in prison till he find sureties that he will not maintain the said heresies or errors any more; but if he relapse, and is convicted a second time, he shall suffer death, as before." There were about seven other real or supposed heresies, besides that which we have just instanced, which were all and every one of them thus punishable by fine, imprisonment, and death. Such was the spirit which at that time influenced those who had caused the press to groan with publications about persecution, liberty, and the rights of private judgment! The clamours, however, about the divine right of Presbytery at length ceased, and the rights of conscience began to be better understood and more generally allowed.

Oliver Cromwell, though he, in some degree, favoured the Presbyterians, disarmed their discipline of its coercive power. Their church censures consequently lost their force, and at length were in a measure discontinued. When Richard Cromwell had resigned the protectorate, the period of their sufferings again, commenced. Duped by General Monk, and deceived by Charles II. whose restoration they had effected, and the life of whose predecessor they had endeavoured to save from the cruelty of the Independents, they were made to discover that their expectations concerning the establishment of a Presbyterian government were to be cut off. Although when the King came to Whitehall ten of them were made his chaplains, before the expiration of the year 1660, many of the parochial clergy were prosecuted for not using the book of Common Prayer; the justices and others insisting that the laws returned with the King. The sequestered clergy came out of their hiding places, and took possession of their former livings, by which some hundreds of the Presbyterian clergy were at once dispossessed; in short, the Church of England was restored to its former power, except only the peerage of the bishops. Now it was that the nation became as completely deluged with licentiousness as it had just before been by enthusiasm and bigotry. The virtues of the Puritans were forgotten or despised, and a torrent of vice and irreligion issued from the court, and overwhelmed the people. Ancient religious ceremonies were revived, and an evident leaning towards popery manifested itself. "To appear serious," says Neale, "to make a conscience of one's words and actions, was the way to be avoided as a schismatic, a fanatic, or a sectarian. They who did not applaud the revived ceremonies were marked out for Presbyterians, and every Presbyterian was a rebel." The vindictive spirit of the restored bishops manifested itself against these unhappy people in every possible way. They were alternately elated with hopes of peace and liberty, and sunk to despair by disappointment and abuse. The doctrines of passive obedience and non-resistance were revived, and an open and flagrant persecution of the Presbyterians was commenced, which continued to increase until the triumph of episcopacy was completed by the Act of Uniformity, which began to be in force on St. Bartholomew's day, in the year 1662. By this act two thousand of the worthiest and most learned men of the time were ejected from their livings, and

exposed to every species of insult, deprivation, and distress. Thus did the hypocritical Charles reward those to whom he was indebted for his restoration to the throne of England! The Presbyterians had now no hopes of justice left, except what they owed to the King's private attachment to the Roman Catholics, and to the exercise of an illegal power in their sovereign, by which the entire liberties of the country might one day be destroyed. This was called the King's dispensing power, under colour of which he pretended to dispense with the execution of the established laws of the realm; thereby, in effect, creating a power above that of the law, and making the monarch an absolute sovereign. It was a painful alternative to the Presbyterians, either to suffer the most shameful deprivations, or countenance the exercise of this usurping power, and thereby endanger the liberties of their country by a kind of unnatural union with the Roman Catholics. In the succeeding reign, when this artifice of universal toleration, and the dispensing power, was again attempted to betray the Protestant interest, the Presbyterians manifested the most honourable disinterestedness, and refused to accept any toleration for themselves that might endanger the general interests of religion, or give countenance to those popish sentiments that had so often deluged their country with the blood of its inhabitants.

In the year 1666 happened the memorable fire of London, a calamity so great and humiliating, that the rancour of bigotry and persecution was somewhat abated by it. This heavy judgment taught the persecutors some useful lessons of righteousness, and the despised Presbyterians were for a time connived at. They built wooden tabernacles to preach in, and their places of worship were crowded with penitent and devout auditors. In two years, however, after the fire of London, their persecutions were revived, and their private assemblies were dissolved. Drs. Patrick and Parker, afterwards bishops, wrote bitterly against them; but Parker met with a formidable, though a sarcastic, antagonist in the famous Andrew Marvel. In 1670, the conventicle act was revived, by which the Presbyterians again suffered the most cruel and vexatious persecutions.

The last penal statute against the Presbyterians was the Test Act, for the repeal of which there was, a few years ago, a very warm but unsuccessful petition from the united body of Protestant Dissenters in this country. This offensive act, which was passed in the year 1673, imports that every person, in office or employment, shall take the oaths of allegiance and supremacy; "receive the sacraments in some parish-church before competent witnesses," and subscribe a declaration, renouncing all belief of the real presence in the eucharist. From this period to the year 1681, various attempts were made, by the successive parliaments, for a toleration of Dissenters, and for putting in force the laws against Popish Recusants; and many books and pamphlets were published in their defence: but all in vain; the court and the papists contrived, to the end of the reign, to oppress the Presbyterians in every possible way. In Feb. 1685 died the thoughtless, the merry, the dissolute Charles II. and with him all hopes of redress or justice on the part of the Dissenters: for whatever were the errors in this prince's conduct, and the blemishes in his character, he was personally beloved by his people, who were overwhelmed with grief and astonishment at his death. He died in the communion of the church of Rome, having received, just before his death, the sacrament at the hands of a Roman Catholic priest.

James, Duke of York, brother to the late King, was crowned, with his Queen, on the 23d of April, 1685. He commenced his reign by disclaiming arbitrary principles, and, at the same time, declaring he would abide by and maintain the religion established by law. James soon gave the nation to understand what he meant by toleration on the one hand, and an adherence to established usages on the other. By toleration, he meant to encourage the principles and the practices of Popery, and by his support of the established religion, he meant the support of the doctrines of passive obedience, and non-resistance. In these principles and determinations he found himself supported by the articles of the English creed, and the importunities of numerous hot-headed Jesuits, by whose influence he suffered himself to be almost invariably guided.

Notwithstanding the plausible pretences of James II. of granting a free toleration to the Dissenters, his drift was easily seen through; and the Dissenters, much to their credit, as we have already remarked, joined with their persecutors of the established church, generously giving up their private resentments, however just, to their fears of Popery and slavery, which were making large strides towards the destruction of

civil and religious liberty, of which the dispensing power, and the declaration for liberty of conscience, were to be the principal engines. This wise conduct of the Dissenters certainly saved the church and state. Thus an end was put to the prosecution of the Protestant Dissenters by the penal laws; though the laws themselves were not legally repealed, or suspended, till after the revolution in 1688. From this happy period of our English history, the condition of the Presbyterians and other Dissenters began gradually to improve. William and Mary, who succeeded to the throne of England, after the abdication of it by James II. were favourable to the Protestant religion, and the rights of conscience. Notwithstanding the violent opposition which William met with from the high-church party, who were a numerous and powerful body, he succeeded, in many points, to soften the rigours, and abate the national prejudice against the Dissenters. Little else has occurred, since the happy era of the revolution, but fruitless attempts for a repeal of the corporation and test acts. It is to be hoped that the time is not far distant, when these, and some other statutes of an oppresive nature, will be repealed, and Englishmen, of whatever religious persuasion, shall feel and acknowledge, that no difference of opinion can divide their interests as Britons, nor disunite their affections as Christians.

Of the religious tenets of the Presbyterians it is not necessary to enlarge very much. They continue to be one of the most numerous and respectable sects of Protestant Dissenters in England; are, doubtless, the richest and most learned body of men out of the pale of the establishment; and have now almost entirely forsaken the rigid and severe maxims of their forefathers. They are denominated Presbyterians from their assertion, that the government of the church, as appointed in the New Testament, is by Presbyters. They acknowledge no head of the church but Jesus Christ. According to the original constitution of the Presbyterian church or congregation, they acknowledge the unity and equality of three persons in the Godhead: but the greater part of the Presbyterians, of the present day, are Unitarians, either what are opprobriously called Arians or Socinians.

They acknowledge the authority and sufficiency of the Holy Scriptures to salvation. They generally believe that all corruption and depravity is contracted, and not original. They are, for the most part, Pædobaptists, and admit the sacrament of the Lord's Supper, which Dr. Watts says, "is eating bread and drinking wine in the church, in remembrance of the death of Christ." They, in general, reject the doctrine of predestination, and some other doctrines intimately connected therewith. The belief and practice of the modern English Presbyterians are pretty faithfully described in "An Abstract of a Profession of Faith made at a public Ordination at the Old Jewry in 1756;" and also in some "Questions proposed to the Rev. Thomas Wright, at his Ordination, May 31, 1759, with the Answers thereto." These papers may be seen in the "History of Religion," published anonymously, in four vols. 8vo. in the year 1764. We close our account of the Presbyterians by observing, that a lecture, first set up in the year 1695, at Salters' Hall, London, is still continued on the original foundation, and is supported by the contributions of the friends of Presbyterianism in the city of London and its vicinity.

PRESENTMENT *of offences*, is that which the grand jury find of their own knowledge, and present to the court, without any bill of indictment laid before them at the suit of the King, as a presentment of a nuisance, a libel, and the like; upon which the officer of the court must afterwards frame an indictment, before the party presented can be put to answer it. There are also presentments by justices of the peace, constables, surveyors of the highways, churchwardens, &c.

PRESS, in the mechanic art, a machine made of iron or wood, serving to squeeze or compress any body very close.

The ordinary presses consist of six members, or pieces; *viz.* two flat smooth planks, between which the things to be pressed are laid; two screws, or worms, fastened to the lower plank, and passing through two holes in the upper; and two nuts, in form of an S, serving to drive the upper plank, which is moveable, against the lower, which is stable, and without motion. Presses, used for expressing of Liquors, are of various kinds: some, in most respects, the same with the common presses, excepting that the under plank is perforated with a great number of holes, to let the juice run through into a tub or receiver underneath. Press used by Joiners to keep close the pieces they have glued, especially panels, &c. of wainscot, is very simple, consisting of four members; *viz.* two screws, and two pieces of wood, four or five inches square, and two

or three feet long; whereof the holes at the two ends serve for nuts to the screws. Press, used by Inlayers, resembles the joiner's press, except that the pieces of wood are thicker, and that only one of them is moveable; the other, which is in form of a tressel, being sustained by two legs or pillars, jointed into it at each end. This press serves them for sawing and cleaving the pieces of wood required in marquetry or inlaid work. Founder's Press is a strong square frame, consisting of four pieces of wood, firmly jointed together with tenons, &c. This press is of various sizes, according to the sizes of the mould; two of them are required to each mould, at the two extremes whereof they are placed; so as that, by driving wooden wedges between the mould and the sides of the presses, the two parts of the mould wherein the metal is to be run may be pressed close together. Rolling-Press is a machine used for the taking off prints from copper plates. It is much less complex than that of the Letter-Printers.

Press, in *Coining*, is one of the machines used in striking of money; differing from the balance, in that it has only one iron bar to give it motion, and press the moulds or coins; is not charged with lead at its extreme, nor drawn by cordage. See Coining.

Press, *Binder's Cutting*, is a machine used equally by book-binders, stationers, and paste-board makers; consisting of two large pieces of wood, in form of cheeks, connected by two strong wooden screws; which, being turned by an iron bar, draw together, or set asunder, the cheeks, as much as is necessary for the putting in the books or paper to be cut. The cheeks are placed lengthwise on a wooden stand, in the form of a chest, into which the cuttings fall. Aside of the cheeks are two pieces of wood, of the same length with the screws, serving to direct the cheeks, and prevent their opening unequally. Upon the cheeks the plough moves, to which the cutting-knife is fastened by a screw; which has its key to dismount it on occasion, to be sharpened. The plough consists of several parts; among the rest a wooden screw, or worm, which, catching within the nuts of the two feet that sustain it on the cheeks, brings the knife to the book or paper which is fastened in the press between two boards. This screw, which is pretty long, has two directories, which resemble those of the screws of the press. To make the plough slide square and even on the cheeks, so that the knife may make an equal paring, that foot of the plough, where the knife is not fixed, slides in a kind of groove, fastened along one of the cheeks. Lastly, the knife is a piece of steel, six or seven inches long, flat, thin, and sharp, terminating at one end in a point, like that of a sword, and at the other in a square form, which serves to fasten it to the plough. See Book-Binding.

As the long knives, used by us in the cutting of books or papers, are apt to jump in the cutting thick books, the Dutch are said to use circular knives, with an edge all round; which not only cut more steadily, but last longer without grinding. Press, in the Woollen Manufactory, is a large wooden machine, serving to press cloths, serges, rateens, &c. thereby to render them smooth and even, and to give them a gloss. This machine consists of several members; the principal whereof are the cheeks, the nut, and the worm or screw, accompanied with its bar, which serves to turn it round, and make it descend perpendicularly on the middle of a thick wooden plank, under which the stuffs to be pressed are placed. The Calender is also a kind of press, serving to press, or calender, linens, silks, &c.

We shall now give an account of some presses much in use, and from which, as they are not to be found in books, we have taken original drawings.

Press, *hop*, (Plate Press) a machine used in breweries for compressing bags of hops into a small compass, that they may take less room for the stowage. In the plantation where the hops are grown, (after being picked, dried, and made ready for sale) they are placed in an upper room which has a hole in the floor, the bag to receive them is hung in this hole, and the hops filled into it, a person gets into the bag when nearly full, and by his weight treads down the hops, that the bag may hold more than it otherwise would, the bag is then removed, and its mouth is sewed up. In this state, the bags go to market, and are sold to the brewer, who conveys them to the brewery ready for use; it is here the hops are pressed into a much smaller compass, as breweries are generally situated in large towns, where warehouse-room is valuable, and where the saving of room amply compensates for the trouble of pressing.

Fig. 1 and 2 are upright elevations, at right angles to each other, of a press for packing hops into bags, made by Mr. Va-

kentine Gotlieb, Lambeth-marsh, Southwark: *a a* is the bottom or fixed bed of the press, firmly bolted to the two upright cheeks, *b b*, which support at their upper end a strong cross beam, B, called the head; the beam, B, is perforated in the middle to receive an iron screw, D. E is a contrate-wheel, of ninety-six teeth, which has a female screw, to admit the male screw, D; the wheel is turned by a pinion of ten teeth, upon the axis of a large crank, *f*, which is turned round by one or two men, according to the power required: these men stand upon a stage, H, fastened to the upright cheeks, *b b*. The lower end of the screw, D, is square, and is keyed into a three-legged iron frame, *h*, bolted to the swinging-bed of the press, I; this is formed of several pieces of thick oak plank, strongly bolted together the fixed bed, K, of the press is framed in the same manner, and supported on the bottom bed: *a a*, *k k*, are two upright beams, fastened at their lower ends to the fixed bed, the press, and at the upper ends are fastened to the frame of the stage, H, on which the men who turn the handle, *f*, stands: one of these beams, *k*, is fixed to the lower bed by a moveable key-bolt; at the upper end it turns on a bolt as a centre, so as to rise up, as shown in fig. 1: *l* is a rope going round a pulley, one end fastened to the beam, the other to a weight which counterbalances the beam.

The operation of the machine is begun by screwing the swinging bed of the press up as high as it will go, and turning up the bar, *k*: a bag, filled with hops, and sewed up, as before described, is then placed on the lower bed, K, and the bar, *k*, brought down and keyed fast, to keep the bag under the press, the man upon the stage, H, then turns the winch, *f*, and by the action of the pinion fixed upon its spindle, turns the wheel, E, and thus brings the screw and the swinging bed of the press down upon the bag, and compresses it into a very small space. A small cord is now passed through the spaces between the pieces of wood, forming the lower side of the swinging bed, and the upper side of the fixed bed, and reefed twice round the bag, and tied fast: the man at the handles now turns it back, and draws up the swinging bed to relieve the bag, the cord retaining it in its compressed state..

In 1798, the Society for the Encouragement of Arts, Manufactures, and Commerce, rewarded Mr. John Peak, of the New Road, near the Adam and Eve, London, with thirty guineas, for an improved packing press, shown in fig. 3, Plate Press, which is a front elevation of the machine, A A, the frame of the press; B B, the large screws, which, in this press, contrary to those in common use, are fixed and immoveable; C, a circular iron bar, extending beyond the sides of the press, and having thereon two worms or endless screws, E, E, which work in two toothed wheels, fixed to the nuts; by turning the winch, D, the nuts and bed are driven up and down the screws, as may be found necessary. F, a stage suspended from the bed, and on which the men stand who work the press; such a stage may, if found necessary, be fixed at the other end of the bar, another winch being put upon the square shoulder, G. The bed of this press must be formed of two pieces of strong wood, which are held together by screws and nuts passed through them, as shown at *h h h h*.

One very considerable advantage of this press is, that much time is saved by its being a double press; for it will very readily be perceived, that when the lower package has been sufficiently pressed, as the bed or presser is raised, (another package being thereon) the upper package begins to be pressed, as that one underneath is relieved, and so alternately, during the whole operation.

PRESSING, in the manufactures, is the violently squeezing a cloth, stuff, &c. to render it smooth and glossy. There are two methods of pressing, *viz.* cold or hot. As to the former, or cold pressing, after the stuff has been scoured, fulled, and shorn, it is folded square in equal plaits, and a skin of vellum, or pasteboard, put between each plait. Over the whole is laid a square wooden plank, and so put into the press; which is screwed down tight by means of a lever. After it has lain a sufficient time in the press, they take it out, removing the pasteboards, and lay it up to keep. Some only lay the stuff on a firm table, after plaiting and pasteboarding, cover the whole with a wooden plank, and load it with a proper weight. The method of pressing hot is this: when the stuff has received the above preparations, it is sprinkled a little with water, sometimes gum water, then plaited equally, and between each two plaits are put leaves of pasteboard; and between every sixth or seventh plait, as well as over the whole, an iron or brass plate well heated in a kind of furnace. This done, it is laid upon the press, and forcibly screwed

down. Under this press are laid five, six, &c. pieces at the same time, all furnished with their pasteboards and iron plates. When the plates are well cold, the stuffs are taken out and stitched a little together to keep them in the plaits. This manner of pressing was only invented to cover the defects of the stuffs; and, accordingly, it has been frequently prohibited.

PRIMÆ *viæ*, among physicians, denote the whole alimentary duct; including the œsophagus, stomach, and intestines, with their appendages.

PRIMATES, in natural history, the first order of Mammalia in the Linnæan system. The animals in this order are furnished with fore-teeth, or cutting-teeth: the four above are parallel: two breasts on the chests. There are four genera, *viz.*

Homo	Simia
Lemur	Vespertilio.

PRIME, an appellation given to whatever is first in order, degree, or dignity among several things of the same or like kind. Thus, we say, the prime minister, prime cost, &c. Prime is sometimes used to denote the same with decimal, or the tenth part of an unit. In weights it stands for the twenty-fourth part of a grain.

PRIME *figure*, in geometry, one which cannot be divided into any other figures more simple than itself, as a triangle among planes, and the pyramid among solids.

PRIME *numbers*, in arithmetic, are those which can be only measured by unity, or exactly divided without a remainder, 1 being the only aliquot part, as 3, 5, 7, 11, 13, &c.: they are sometimes called simple, or incomposite numbers. No even number is prime, because all even numbers are divisible by 2. Numbers ending in 0 and 5, are not prime, because they are all divisible by 5, and those ending in 0 by 10 also.

PRIME *of the moon*, is the new moon, when she first appears, which is about three days after the change.

PRIME *vertical*, is that vertical circle which passes through the poles of the meridian, or the east and west points of the horizon; whence dials projected on the plane of this circle are called prime vertical, or north and south dials.

PRIMING, or *Prime of a Gun*, is the gunpowder put into the pan or touch-hole of a piece, to give it fire thereby. And this is the last thing done in charging. For pieces of ordnance they have a pointed iron rod, to pierce the cartridge through the touch-hole, called primer or priming-iron.

PRIMING, among painters, signifies the laying on of the first colour.

PRIMITIÆ, the first fruits gathered of the earth, whereof the ancients made presents to the gods. In our law, the primitiæ are one year's profits, after avoidance of every spiritual living, as rated in the King's books.

PRIMITIVE, in grammar, is a root or original word in a language, in contradistinction to derivative. Thus, *God* is a primitive, *godly* derivative, and *god-like* a compound.

PRIMULA, in botany, *primrose*, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: involucre of an umbellet; corolla tube cylindrical with a spreading mouth. There are twenty species.

PRIMUM *mobile*, in the Ptolemaic astronomy, the ninth or highest sphere of the heavens, whose centre is that of the universe.

PRINCE, in polity, a person invested with the supreme command of a state, independent of any other. Prince also denotes a person who is a sovereign in his own territories, yet holds of some other as his superior; such are the princes of Germany, who, though absolute in their respective principalities, are bound to the Emperor in certain services. Prince also denotes the issue of princes, or those of the royal family. In France, they are called princes of the blood. In England, the King's children are called sons and daughters of England: the eldest son is created Prince of Wales. The cadets are created Dukes or Earls, as the King pleases. And the title of all the children is royal highness: all subjects are to kneel when admitted to kiss their hand, and at table, out of the King's presence, they are served on the knee. It is high treason to violate the eldest daughter unmarried.

The Prince of Wales is born Duke of Cornwall, and immediately entitled to all the revenues belonging thereto. He is afterwards created Prince of Wales by investiture with a cap, coronet, gold verge, and ring, and he holds it by patent. The title and principality were first given by Edward I. to his eldest son. While Normandy remained to England, he was styled Duke of Normandy; but since the union his title is Magnæ Britanniæ Princeps. He

is reputed, in law, the same person with the King; to imagine his death, or violate his wife, is high treason.

PRINCIPAL, the chief and most necessary part of a thing. In commerce, principal is the capital of a sum due or lent, so called in opposition to interest. It also denotes the first fund put by partners into a common stock, by which it is distinguished from the calls or accessions afterwards required.

PRINCIPAL *point*, in perspective, is a point in the perspective plane, upon which a line drawn from the eye perpendicular to the plane falls. It is in the intersection of the horizontal and vertical plane, and called the point of sight, and point of the eye. See PERSPECTIVE.

PRINCIPAL *ray*, in perspective, that which passes perpendicularly from the spectator's eye to the perspective plane. See PERSPECTIVE.

PRINOS, in botany, *winter-berry*, a genus of the Hexandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx six-cleft; corolla one-petalled, wheel-shaped; berry six-seeded. There are seven species.

PRINTERS, *marks of*. See PRINTING.

PRINTING, the art of making an impression upon one body by pressing it with another. This art, in some way or other, has been known in all ages. It has been done upon wax, upon plaster, upon iron, by the ancients; their seals, their rings, their money, prove it. It has been done with wooden blocks upon cotton and silk by the Indians. Printing, therefore, in this limited sense, was common to all nations. This art is now divided into four distinct branches: 1. Common, or letter-press printing. 2. Rolling-press printing. 3. Calico-printing. 4. Stereotype-printing.

Printing by letter-press is the most curious branch of the art, and demands the most particular notice. It has been often remarked, that as seven cities in Greece disputed for the birth of Homer, so three cities in Europe, Haerlem, Strasbourg, and Mentz, claim the honour of the invention of printing.

Without entering minutely into the disputes which have long agitated the minds of those who have felt a particular interest in this investigation, we state it as our opinion, that Guttemberg was the inventor of the art of printing by moveable types; that he began the art at Strasbourg, and perfected it at Mentz. In this opinion, the earliest writers who mention printing are all agreed.

That the first attempts at printing were made at Strasbourg is, we think, incontestably proved by the following circumstances. John Guttemberg entered into a partnership with Andrew Drizehennius, John Riff, and Andrew Heilmann, all citizens of Strasbourg, binding himself to discover to them some important secrets, whereby they should make their fortunes. Each at first contributed eighty florins, and afterwards 125. The workshop was in the house of Andrew Dritzehen, who died. Guttemberg immediately sent his servant Beildeck to Nicholas, the brother of the deceased, to request him to suffer no one to enter the workshop, lest the secret should be discovered, and the *forms* stolen. But this had already been done. This theft, and the claim which Nicholas made to succeed to his brother's share, occasioned a law suit, and the evidence of the servant affords explicit and incontrovertible proof in favour of Guttemberg, as the first who practised the art of printing with moveable types. The document, containing the account of this trial, &c. is dated 1439. It was published in the original German, with a Latin version, by Schopflin, in his "Vindiciæ Typographicæ." M. Lambinet, in his "Recherches Historiques sur l'Origine de l'Art de l'Imprimerie," published at Paris a few years ago, says, that the German is obscure, and that every one will interpret the equivocal words in favour of his own opinion. It is, however, manifest that Guttemberg expressly ordered that the *forms* should be broken up, and the characters dispersed; a fact clearly proving, that the art of printing was at that time a secret, and that moreover it was performed with moveable types. Guttemberg, after having sunk what he and his associates had embarked in this speculation, returned to Mentz, where he was born, and succeeded better in a partnership with Fust.

The evidence in favour of Guttemberg appearing to us decisive, we shall not enter into any examination of the claims advanced by the other candidates for the honour of being the inventor of the art of letter-press printing. The names of those persons were John Fust, of Mentz; John Mental, of Strasbourg; and L. John Koster, of Haerlem. When the city of Mentz was taken by Adolphus, Count of Nassau, in 1462, Fust, and Schoeffer, servant and son-in-law to Fust, suffered materially with their fellow townsmen. Their associates and workmen dispersed to seek their fortunes, and the art was thus

diffused over Europe. When it was first established at Paris, the copiers, finding their business so materially injured, presented a memorial of complaint to the parliament, and that tribunal, as superstitious as the people, who took the printers for conjurers, had their books seized and confiscated. Louis XI. who, villain as he was, was the friend and patron of letters, forbade the parliament to take any farther cognizance of the affair, and restored their property to the printers.

The art of printing now began to spread itself over a great part of Europe with astonishing rapidity. It was practised at Rome in the year 1467, and the year following it was introduced into England by Thomas Bourchier, Archbishop of Canterbury, who sent W. Turner, master of the robes, and W. Caxton, merchant, to the continent to learn the art. Turner and Caxton met with one Corseilles, an under-workman, whom they bribed with considerable presents and large promises, to come over to England, and instruct them in the art. This business having been accomplished, a press was set up at Oxford, which was afterwards removed to St. Albans, and after that to Westminster Abbey. The learned Dr. Conyers Middleton, and others, are inclined to doubt the truth of this part of the history of printing. It is certain, that Caxton did not return immediately to England, but continued some time on the continent, following the business of a printer. Indeed, both the origin and the history of the first introduction of the art of printing into this country are involved in doubt and obscurity, and nothing has ever yet been published perfectly satisfactory on this subject. We will, therefore, proceed to an account of

THE METHOD OF PRINTING.

The workmen employed in this art are compositors and pressmen. The first are those persons whose business it is to range and dispose the letters into words, lines, pages, &c. The pressmen are those who, properly speaking, are the printers, as they take off the impressions from the letters after they are prepared for that purpose by the compositors. The types being provided for the compositor, he distributes each kind, or *sort*, by itself, into small cells or boxes, made in two wooden frames, called the *cases;* the upper-case and the lower-case. The cells in the upper-case are ninety-eight in number; those of the lower-case are fifty-four.

The upper-case contains two alphabets of capitals; large, or full capitals, and small capitals. They also contain cells for the figures, the accented letters, the characters used in references to notes, &c.; and one cell, being a middle one in the bottom row, for the small letter, k. The capitals in this case are disposed alphabetically.

The lower-case is appropriated to the small letters, the double letters, the points, parentheses, spaces, and quadrats. The boxes of the lower-case are of different sizes; the largest being for the letters most in use; but the arrangement is not in this instance alphabetical, those letters oftenest wanted being placed nearest to the compositor's hand. As there is nothing on the outside of the boxes to denote the letters they respectively contain, it is curious to observe the dexterity manifested by the compositor in finding and taking up the letters, as he wants them, from the different cells. Each case is placed in an inclined direction, that the compositor may reach the upper-case with ease.

The instrument in which the letters are set is called a composing-stick, which consists of a long plate of brass or iron, on the side of which arises a ledge, which runs the whole length of the plate, and serves to support the letters, the sides of which are to rest against it. Along this ledge is a row of holes, for introducing a screw to lengthen or shorten the line, by moving the sliders farther from, or nearer to, the shorter ledge at the end of the composing stick. Where marginal notes are required, the two sliding pieces are opened to a proper distance from each other. Before the compositor begins to compose, he puts a thin slip of brass plate, called a rule, cut to the length of the line, and of the same height as the letter, in the composing stick, parallel with the ledge, against which the letters are intended to bear. The compositor being thus furnished with an instrument suited to hold the letters as they are aranged into words, lines, &c. he places his copy on the upper-case, just before him, and holding the stick in his left hand, his thumb being over the slider, with the right he takes up the letters, spaces, &c. one by one, and places them against the rule, while he supports them with his left thumb, by pressing them against the slider, the other hand being constantly employed in setting in other letters. Having in this manner composed a line, he takes the brass rule from behind it, and places it before the letters of which it is composed, and

proceeds to compose another line in the same manner. But before he removes the brass rule, he notices whether the line ends with a complete word, or with an entire syllable of a word, including the hyphen that is put to denote the division, when a word is divided into syllables. If he finds that his words exactly fill the measure, he has nothing more to do with that line, but proceeds with the next. But if he finds the measure not entirely filled at the ending of a word or syllable, he puts in more spaces, diminishing the distances between the words, until the measure is full; and this operation, which is called *justifying*, is done in order that all the lines in the composing-stick may be of equal length. Much depends upon exactness in *justifying;* and great care is taken by expert compositors that the lines are neither too closely wedged into the composing stick, nor yet loose and uneven.

The spaces are pieces of metal, of various thicknesses, exactly shaped like the shanks of the letters. They are used to regulate the distances between the words.

When the composing-stick has been filled with lines, being generally in number about ten or twelve, the compositor empties it, on to a thin board, called a galley, being of an oblong shape, with a ledge on two sides, and a groove, to admit a false bottom. When the compositor has filled and emptied his stick until he has composed a page, he ties it up with a piece of pack-thread, and removes it from the galley, either to the imposing-stone, or to such other safe and convenient place as he may think proper. And in this manner he proceeds until he has composed as many pages as are required to make a sheet, or, in some instances, a half-sheet. He then proceeds to arrange the pages on the imposing-stone, which is a very large oblong stone, of about five or six inches in thickness. The pages are so arranged, that, when they are printed, they may be folded so as to follow each other regularly. Great care, and some ingenuity, is requisite in the imposing of a sheet or half-sheet, particularly of works in sizes less than folio or quarto. In Stower's Printer's Grammar, a very excellent and copious work on the subject of printing, are given upwards of fifty schemes of imposition, of sheets of almost every possible size.

Having laid down or disposed the pages in right order on the imposing-stone, the comppositor proceeds to what is called dressing the chases. The chase is a rectangular iron frame, of different dimensions, according to the size of the paper to be printed; having two cross pieces, of the same metal, called a long and short cross, mortized at each end so as to be taken out occasionally. By the different situations of these crosses the chase is fitted for different volumes; for folios, quartos, octavos, &c. To dress the chase, a set of furniture is necessary, consisting of small slips of wood of different dimensions. The first thing to be done, is to lay the chase over the pages; after this, that part of the furniture called gutter-sticks, are placed between the respective pages. Then another part of the furniture called reglets are placed along the sides of the crosses of the chase. The reglets are of such a thickness as will let the book have proper margins after it is bound. Having dressed the inside of the pages, the compositor proceeds to do the same with their outsides, by putting side-sticks and foot-sticks to them. Thus the pages being placed at proper distances, they are all untied, and fastened together by small wooden wedges, called quoins. These small wedges, being firmly driven up the sides and feet of the pages, by means of a mallet, and a piece of hard wood called a shooting-stick, all the letters are fastened together. The work in this condition is called a form, and is ready for the pressman, who lays it upon the press, for the purpose of pulling a proof. When a proof is pulled, the form or forms are rubbed over with a brush, dipped in ley, made of pearl-ash and water; they are then carefully taken off the press, and the proof and forms delivered to the compositor's further care.

As it is impossible for the most careful compositor so to compose all his sheets as that they shall not require to be carefully read and corrected before they are finally worked-off, the next thing to be done is to put the proof, along with the copy from which it has been composed, into the hands of the reader or corrector, whose business is to read over the whole proof two or three times with great care and attention, marking such errata in the margin of every page as he shall observe.

The corrections are always placed against the line in which the faults are found. There are different characters used to denote different corrections: thus ⌣ is put to signify that a word is divided that ought to be in one, as *pe rson* instead of *person;* a mark

resembling the Greek theta ϑ is put for *dele*, to intimate that something, as a point, letter, word, &c. dashed in that line, is to be taken out. If any thing is to be inserted, the place of insertion is marked with a caret, ‸, and the thing to be inserted written in the margin. Where a space is wanting between two words, or letters, that are intended to be separated, a parallel line must be drawn where the separation ought to be, and a mark, somewhat resembling a flat in music #, placed in the margin. An inverted letter or word, is noticed by making a dash under it, and a mark, nearly resembling the *dele* character reversed.

Mr. Stower observes, that marking turned letters tries a corrector's skill in knowing the true formation of them; without which it would be better to mark them in the same manner as they do wrong letters, which is done by dashing out the wrong letter, and writing the right one in the margin, unless they are very sure that they can distinguish b, d, n, o, p, q, s, u, x, z, when they are turned, from the same letters with their nick the right way. Where a space rises up between two words, it is noticed by a cross + in the margin. When any thing is transposed it is denoted thus:

1 4 3 2
You merit your mistake

for *You mistake your merit*; and in the margin is added *tr.* for transposition. Where a new paragraph is required, a line in the shape of a crotchet [is made, and the same mark placed in the margin; also where a paragraph ought not to have been made, a line is drawn from the broken-off matter to the next paragraph; and in the margin is written *No break*. If Italic letters are to be changed for Roman, or *vice versa*, a line is drawn, thus ——, under the letters, and *Rom.* or *Ital.* is written in the margin. Where words have been struck out that are afterwards approved of, dots are marked under such words, and in the margin is written the word *stet*. Where the punctuation is required to be altered, the semicolon, colon, and period, are encircled in the margin. The comma and other points are marked as letters and words, *viz.* with a long oblique line immediately before them; which line is intended to separate the different corrections from each other that occur in the same line. When letters of a different fount or size are improperly introduced into the page, they are noticed by a small dash drawn through them, and the letters *w. f.* in the margin. There are some other marks used in correcting; such as ✓ for superior; where it is necessary to insert the apostrophe, the star, or other reference marks, and superior letters: *Cap.* for capital, *L. C.* for lower case, &c.

After a proof sheet has been read, and the errata thus noticed by the corrector, or, as he is more usually called, the reader, it is again put into the hands of the compositor, who proceeds to correct in the metal what has been marked for correction in the proof. He then unlocks the form on the imposing-stone, by loosening the quoins or wedges which bound the letters together. He then casts his eye over one page of the proof, noticing what letters, &c. are required. Having gathered as many corrections, from the cases, between the thumb and fore-finger of his left hand, as he can conveniently hold, and an assortment of spaces, on a piece of paper, or in a small square box with partitions in it, he takes a sharp-pointed steel bodkin in his right hand. Placing the point of the bodkin at one end of the line, and the fore-finger of his left hand against the other, he raises the whole line sufficiently high to afford him a clear view of the spacing. He then changes the faulty letters or words, and alters his spaces before he drops the line.

The first proof being corrected, another is pulled, to be again put into the hands of the reader, or sent to the author for examination. This proof being read and corrected as before, a *revise* is pulled, to see whether all the errors marked in the last proof are properly corrected. When the sheet is supposed to be correct, the forms are given to the pressman, whose business it is to work them off when they are so prepared and corrected; in doing which four things are required; paper, ink, balls, and a press. The paper is prepared for use by being dipped, a few sheets at a time, in water, and afterwards laid in a heap over each other, to make the water penetrate equally into every sheet, a thick deal board is laid upon the heap, on which is placed heavy weights according to the size of the heap. The reason why the paper is to be wetted before it is in a fit state to be printed upon, is, that it may be made sufficiently soft to adhere closely to the surface of the letter, and take up a proper quantity of ink, that it may receive a fair and clear impression. It is also necessary to wet the paper, lest its stiff and harsh nature, when dry, should injure the face of the letters.

The ink used by printers has already been treated of in the article INK, which see. The manufacture of good common ink seems to be as yet but very imperfectly understood. That used in fine printing has been more attended to, and many of our best printers are now able to produce impressions in a great degree free from that offensive brown cast which is to be observed in many books printed with what is called common ink.

The balls used in laying the ink on the forms are a kind of wooden funnels, with handles, the cavities of which are stuffed with wool or hair, and covered over with a pelt prepared for the purpose. One skin generally makes two proper sized balls. When the skin has been sufficiently soaked in urine, which will take about fourteen or fifteen hours, it is taken out and curried, by putting it round an iron called a currying iron, or round some upright post: the pressman taking hold of each end of it, and drawing it with as much force as possible backwards and forwards, till it is rendered soft and pliable. He then cuts the skin exactly in two, puts them under his feet, and continues to tread them till they are so dry as to stick to the foot in treading. The skin is then laid on a board or flat stone, and stretched as much as possible by rubbing the ball-stock upon it. It is then nailed upon the ball stock in plaits about an inch wide, thrusting in as much wool as the cavity of the stock and the skin will conveniently hold. If, however, too much wool were to be put in, it would render the balls hard and difficult to work with. If too little wool is in the balls, they soon flap and wrap over into wrinkles, so as to prevent an equal distribution of the ink on their surface. When the balls are thus knocked up, as it is termed, they are dipped in urine, and scraped with a blunt knife until they are perfectly clean; they are then dried with a clean sheet of stout paper, and patted with the hand until no moisture remains on the surface. The balls, when they are completed, have much the shape and appearance of a very large mallet, used by stone masons, except that their surface is much broader and rounder.

The press is a curious and complex machine: it consists of two upright beams, called cheeks; they are generally about six feet one inch long, eight inches and a half broad, and five inches thick, with a tenon at each end. The tenon at the upper end of the cheek is cut across the breadth, and enters the cap within half an inch of the top. The cap is a piece of solid timber, three feet long, eleven inches wide, and four inches thick. The lower tenon of the cheek enters the feet, which is a square wooden frame made very thick and strong. The head, which is moveable, is sustained by two iron bolts that pass through the cap. The spindle is an upright piece of iron, pointed with steel, having a male screw which goes into the female one in the head about four inches. This spindle is so contrived, that when the pressman pulls a lever, which is attached to it, the pointed end of it works in a steel pan or cup supplied with oil, which is fixed to an iron plate let into the top of a broad thick piece of mahogany, with a perfectly plane surface, called the platten. This platten is made to rise and fall as the pressman pulls or let go the lever or bar. When the platten falls, it presses upon a blanket, by which the paper is covered when it lies upon the form, from which the impression is intended to be taken. The form is laid upon a broad flat stone, or thick marble slab, which is let into a wooden frame, called the coffin, and which is made to move backwards or forwards, by the turning of a wince, or rounce. At the end of the coffin are three frames; two of which are called tympans, and the remaining one a frisket.

The tympans are square, and are made of three slips of very thin wood, and at the top a piece of iron, still thinner; that called the outer tympan is fastened with hinges to the coffin; they are both covered with parchment, and between the two are placed blankets, which are necessary to take off the impression of the letters upon the paper. The frisket is a square frame of thin iron, fastened with hinges to the tympan; it is covered with paper cut in the necessary places, that the sheet, which is put between the frisket and the outer tympan, may receive the ink, and that nothing may hurt the margins. To regulate the margins, a sheet of paper is fastened upon this tympan, which is called the tympan sheet, and which ought to be changed whenever it becomes wet with the paper to be printed upon. On each side is fixed an iron point which makes two holes in the sheet, which is to be placed on the same points when the impression is to be made on the other side. In preparing the press for working, or as it is called by pressmen, making ready a form, great care and attention is requisite that the printed sheets

may be in proper register, *i. e.* that the lines on one side may exactly fall upon the backs of the other. That the impression may be equable, the parchment which covers the outer tympan is wetted till it is very soft; the blankets are then put in and secured from slipping by the outer tympan. When the form is made ready, and every thing is prepared for working, one man beats the letters with the ink balls, another places a sheet of paper on the tympan sheet, turns down the frisket upon it to keep the paper clean and prevent its slipping, then bringing the tympan upon the form, and turning the rounce, by which the carriage, holding the coffin, stone, and form, is moved, he brings the form with the stone, &c. under the platten; pulls with the bar, by which the platten presses the blankets and paper close upon the letter, whereby half the form is printed, then easing the bar, he draws the form still forward, gives a second pull, and letting go the bar, turns back the carriage, &c. raises the tympans and frisket, takes out the printed sheet and lays on a fresh one; and this is repeated till he has taken off the impression upon the full number of sheets of which the edition is to consist. One side of every sheet being thus printed, the form for the other side is laid on the press, and worked off in the same manner.

Mr. Stower very justly remarks, "that this, the common press, is constructed on the true principles of mechanism." It does not, however, he allows, produce an adequate impression from heavy works in small letter, without great labour and attention. It was therefore a great acquisition to gain an accession of power, with, at the same time, a diminution of labour.

This valuable acquisition in the art of printing owes its invention to that enlightened and patriotic statesman, the present Earl Stanhope. The iron press, invented by this nobleman, is capable of ten times the force of the common press, with, perhaps, a tenth of the labour. In working upon this press, nothing is left to the judgment of the pressman but the beating.

To describe the construction of the Stanhope press would not only much exceed our limits, but would require a considerable number of plates, as its internal construction cannot be sufficiently delineated by any general view of it. It is, however, a most compact and curious machine, and is an invention altogether worthy of the genius of the nobleman who first constructed it. A very minute account of the nature and construction of every part of this press is given in Mr. Stower's Grammar.

The Stanhopian principle has been applied in the construction of the common press, but we understand not with that success which was at first expected. The presses, however, so formed, and first made by Mr. Baker, are superior to the common press, and produce a more clear and strong impression, especially from light forms; though the sharpness, as well as smoothness of impression, produced by the Stanhope press, from forms of pearl and nonpareil letter, is not to be expected from the common presses constructed on the Stanhopian principle. See ENGRAVING, and CALICO PRINTING.

In an article of this nature, it would argue a want of taste or discernment to omit the mention of Mr. M'Creery's very elegant and beautiful poem, entitled "The Press," published as a specimen of typography. It is indeed a beautiful work, and does great credit both to the genius of the author as a poet, and to his care and talents as a printer. It is published by Messrs. Cadell and Davis, in the Strand.

PRINTING, *stereotype*. Perhaps it would not have been improper to have treated of stereotype printing even before that of common printing: for the first ideas of this art were certainly anterior to those of printing by moveable types.

The method of printing linen and paper for hangings has been known in the east from time immemorial. Printing from wooden blocks, by the Jesuits, has been practised above sixteen hundred years in China. According to this plan, when an author chooses to print his work, he has it fairly transcribed upon a thin and transparent paper. Each leaf is then reversed and fastened upon a smooth block of hard wood, upon which the engraver cuts the characters, in relief. There must be, therefore, a separate block for every page.

At the end of the fourteenth and beginning of the fifteenth century, the Italians, Germans, Flemings, and Dutch, began at the same time to engrave on wood and copper: but the previous advances had been gradual. The inscriptions, in relief, upon monuments and altars, in the cloisters and over church porches, served as models for block-printing. The letters upon painted windows greatly resemble those in the books of images. The invention of cards was an intermediate step. Bullet, in his "Recherches Historique sur les Cartes à

jouer," has proved from old chronicles, in particular from that of Petit-Jean de Sanitre, from edicts civil and ecclesiastical, and from the figures of the cards, that they were invented towards Charles the Fifth's reign, about the year 1376. By the shape of the crowns, and the sceptres with the *fleur de lis*, he infers that the French invented them. They soon were introduced into Spain, Italy, Germany, and England. The names of the suits seem rather to imply a Spanish or Italian origin. At first the cards were painted; about the year 1400 a method was devised of printing them from blocks. To this we may directly trace the art of printing. The books of images form the next step. These also were printed from wooden blocks; one side of the leaf only is impressed, and the corresponding text is placed below, beside, or proceeding from the mouth of the figure. Of these scarce books, M. Lambinet mentions seven: 1. Figuræ typicæ veteris atque antitypicæ novi testamenti. This is the work which in Germany is called the Bible of the Poor, because it was originally designed as an abridgement of the Bible for those who could not purchase the whole scriptures in manuscript, and who probably could not read. There is one copy of this work in the Bodleian Library, and another at Christ's College, Cambridge. 2. Historia S. Joannis Evangelistæ, ejusque visiones apocalypticæ. 3. Historia seu Providentia Virginis Mariæ, ex cantico canticorum. 4. Ars moriendi. 5. Ars memorandi notabilis per figuras Evangilistarum. 6. Donatus, seu grammatica brevis in usum scholarum conscripta. It is not easy to conceive how this can be classed among the books of images. 7. Speculum humanæ salvationis. There is said to be an English translation of this work. Two other books of images, the Tewrdanck, and the Triumpf-wagen, are posterior to the common use of printing. It is clear, therefore, from the cotton and silk printing of the Indians, the Chinese block-printing, and these books of images; and perhaps, also, from the bardic mode of writing, who cut their poems upon bars of wood, arranged like a gridiron, and which they called carving a book, that the idea of stereotype printing is by no means of modern origin. That it was prior to the art of printing with moveable types there can be no doubt; since this latter mode of printing was first suggested by the Catholicon, which was printed with wooden tablets, in a series, and composed in forms. This mode of printing, except in China, where it is still practised, was laid aside soon after the invention of the common letter-press printing.

The history of the invention of modern stereotype is, like that of common printing, involved in some obscurity as to the name of the person to whom justly belongs the honour of an invention so useful and curious. Mr. Andrew Tilloch, the worthy and ingenious editor of the Philosophical Magazine, has given the following extract, translated from Niewe Algemein Konst en Letter Bode, 1798, No. 232, which deserves particularly to be noticed. "Above a hundred years ago the Dutch were in possession of the art of printing with solid or fixed types, which in every respect was superior to that of Didot's stereotype. It may, however, be readily comprehended that their letters were not cut in so elegant a manner, especially when we reflect on the progress which typography has made since that period. Samuel and J. Leuchtman's, booksellers at Leyden, have still in their possession the forms of a quarto Bible, which were constructed in this ingenious manner. Many thousand impressions were thrown off, which are in every body's hands, and the letters are still good.

"The inventor of this useful art was J. Vander Mey, father of the well-known painter of that name. About the end of the sixteenth century he resided at Leyden. With the assistance of Muller, the clergyman of the German congregation there, who carefully superintended the correction, he prepared and cast the plates for the above-mentioned quarto Bible. This Bible he published also in folio, with large margins, ornamented with figures; the forms of which are still in the hands of Elwe, bookseller at Amsterdam: also an English New Testament, and Schaaf's Syriac Dictionary; the forms of which were melted down: likewise a small Greek Testament, in 18mo.

"As far as is known, Vander Mey printed nothing else in this manner; and the art of preparing solid blocks was lost at his death, or at least was not afterwards employed." The Dutch editor supposes that the reason why Vander Mey's invention was dropped was that "though this process in itself is very advantageous, it is far more expensive than the usual method of printing, except in those cases where such works are to be printed as are indispensibly necessary, and of standing worth." Mr. Tilloch, however, is of a directly contrary opinion.

In the year 1781 was printed, by and for J. Nichols, London, a very interesting pamphlet, entitled Biographical Memoirs of William Ged; including a particular account of his progress in the art of block-printing. The first part of the pamphlet was printed from a MS., dictated by Ged some time before his death; the second part was written by his daughter, for whose benefit the profits of the publication were intended; the third is a copy of proposals that had been published by Mr. Ged's son, in 1751, for reviving his father's art, and to the whole is added Mr. Mores's Narrative of Block Printing.

It appears from this publication, that, in the year 1725, Mr. Ged began to prosecute plate-printing. In 1727, he entered into a contract with a person who had a little capital, but who, on conversing with some printer, got so intimidated, that, at the end of two years, he had laid out only twenty-two pounds. In 1729, he entered into a new contract with a Mr. Fenner, Thomas James, a type-founder, and John James, the architect. Sometime after, a privilege was obtained from the University of Cambridge, to print bibles and prayer-books; but it appears, that one of his partners was actually averse to the success of the plan, and engaged such people for the work as he thought most likely to spoil it. A straggling workman, who had wrought with them, informed Mr. Mores, that both bibles and common prayer-books had been printed; but that the compositors, when they corrected one fault, made purposely half a dozen more; and the pressmen, when the masters were absent, battered the letter in aid of the compositors. In consequence of these base proceedings, the books were suppressed by authority, and the plates sent to the King's printing-house, and from thence to Mr. Caslon's foundry. "After much ill usage," says Mr. Tilloch, "Ged, who appears to have been a person of great honesty and simplicity, returned to Edinburgh. His friends were anxious that a specimen of his art should be published, which was at last done by subscription. His son, James Ged, who had been apprenticed to a printer, with the consent of his master set up the forms in the night-time, when the other compositors were gone, for his father to cast the plates from; by which means Sallust was finished in 1736." Mr. Tilloch has not only a copy of this work, but also "the plate of one of the pages." Besides Sallust, Mr. Tilloch has another work, printed some years after, from plates of Mr. Ged's manufacture. The book is The Life of God in the Soul of Man, printed on a writing pot, 12mo. and with the following imprint: "Newcastle, printed and sold by John White, from plates made by William Ged, Goldsmith in Edinburgh, 1742."

Fifty years after the invention of plate-printing by Mr. Ged, Mr. Tilloch made a similar discovery, without having, at the time, any knowledge of Ged's invention. In perfecting the invention, Mr. Tilloch had the assistance and joint labour of Mr. Foulis, printer to the University of Glasgow. After great labour, and many experiments, these gentlemen "overcame every difficulty, and were able to produce plates, the impressions from which could not be distinguished from those taken from the types from which they were cast." "Though we had reason to fear," says Mr. Tilloch, "from what we [afterwards] found Ged had met with, that our efforts would experience a similar opposition, from prejudice and ignorance, we persevered in our object for a considerable time, and at last resolved to take out patents for England and Scotland, to secure ourselves, for the usual term, the benefits of our invention; for the discovery was still as much our own as if nothing similar had been practised before. Ged's knowledge of the art having died with his son, whose proposals for reviving it, published in 1751, not having been followed with success, he went to Jamaica, where he died. The patents were accordingly obtained; nay, they are even expired; and yet we hear people, who only began their stereotype labours yesterday, taking to themselves the merit of being the first inventors!" "Owing to circumstances of a private nature;" not, however, connected with the stereotype art, the business was laid aside for a time; and Mr. Tilloch, having removed from Glasgow to London, the concern was dropped altogether; not, however, till several small volumes had been stereotyped and printed, under the direction of Messrs. Tilloch and Foulis.

Some time elapsed after this, when Didot, the celebrated French printer, applied the stereotype art to logarithmic tables, and afterwards to several of the Latin classics, and to various French publications. It has been said, by the French, that the merit of the invention properly belongs to

Didot; but by what we have already laid before our readers, it is evident this cannot have been the case.

Some years after Mr. Tilloch had given up the prosecution of this art, Mr. Wilson, a printer of respectability in London, engaged with Earl Stanhope for the purpose of bringing it to perfection, and eventually to establish it in this country. His Lordship, it is said, received his instructions from Mr. Tilloch, and had afterwards the personal attendance of Mr. Foulis, for many months, at his seat at Chevening, where his Lordship was initiated in the practical part of the operation.

After two years application, Mr. Wilson announced to the public "that the genius and perseverance of Earl Stanhope, whom he styles "the Right Honourable Inventor," had overcome every difficulty; and that accordingly, the various processes of the stereotype art had been so admirably contrived, combining the most beautiful simplicity with the most desirable economy, the *ne plus ultra* of perfection with that of cheapness, as to yield the best encouragement to the public for looking forward to the happy period when an application of this valuable art to the manufacture of books would be the means of reducing the prices of all standard works at least thirty, and in many cases fifty per cent.

In January, 1804, the stereotype art, (with the approbation of Lord Stanhope,) was offered by Mr. Wilson to the University of Cambridge, for their adoption and use in the printing of bibles, testaments, and prayer-books, upon certain terms and conditions highly advantageous to Mr. Wilson; for, with his Lordship's characteristic generosity, Earl Stanhope has uniformly declined to accept even the reimbursement of any part of the monies by him expended in the prosecution of this ingenious art. Some differences, however, arising between Mr. Wilson and the Syndics of the University, the contract was dissolved; and Mr. Wilson published his case in a stereotyped pamphlet, entitled "Arbitration between the University of Cambridge and Andrew Wilson."

That Mr. Wilson might make out his case more clearly, he has given a "Computation of the nonpareil bible,—showing the expenditure by both methods of printing, upon composition, reading, wear of type, and charges of composition; and upon paper, press-work, charges on press-work, and insurance." This computation is, of course, much in favour of the stereotype art; amounting indeed to nearly one half, or fifty per cent. saved by the new method. In addition to the saving attributed to stereotype printing, it is said that, as every page of the most extensive work has a separate plate, all the pages of the said work must be equally new and beautiful: which cannot be the case with single types, which are distributed and recomposed several times over in the course of a large work. The stereotype art also, it is said, possesses a security against error. This advantage is much insisted on by the friends of the art; but with what consistency, we confess, does not immediately appear: for, strange as it may seem, after all the care that we may naturally suppose was taken to render Mr. Wilson's pamphlet a model of stereotype perfection, it is still not without its errata. The pamphlet consists of about forty-four pages; and on the forty-first page, in a line containing only two monosyllables, there is an error: (viz.) *viod* for *void*. There are one or two other trifling inaccuracies in the pamphlet; which afford demonstrative proof that

> "Whoever thinks a faultless piece to see,
> Thinks what ne'er was, nor is, nor e'er shall be."

Indeed, as every work hitherto stereotyped clearly manifests, it is not possible that first editions of works should be more correct when stereotyped than when printed in thecommon way; and it ought not to be forgotten that an error stereotyped in the first edition is perpetuated through every subsequent edition. It is said, that stereotype plates admit of alteration: this however, if carried to any extent, must be attended with a very considerable expense.

In short, we think that the stereotype art has much the advantage of common printing in standard books of very extensive circulation and constant demand, and wherein no alteration, as to plan or size, is allowed ever to take place: but for the common and most general purposes of the art of printing, the method by moveable types is incomparably the best.

The precise method adapted in stereotype printing being hitherto a secret known only to a few, our readers will perceive that we can only, as we have done, give a general history of the invention. The mode of stereotype printing is, however, generally,

first to set up a page, for instance, in the common way, with moveable types; and when it is rendered as correct as the nature of the thing will admit, a cast is taken from it, and in this cast the metal for the stereotype plate is poured; and so for every page or sheet of a work intended to be stereotyped. When the plates are prepared, they are printed off at the Stanhope press; and it must be confessed, that the works hitherto published, that have been printed in this manner, are very beautiful, and to the full as correct as the best editions of books, printed according to the common method. But as it does not appear that any actual saving can be obtained in the manufacture of books in general, the London publishers have not yet thought it worth their while to patronize and encourage this curious invention.

PRISM, in geometry, an oblong solid, contained under more than four planes, whose bases are equal, parallel, and alike situated. The prism is generated by the motion of a rectilinear figure, descending always parallel to itself, along a right line. If the describent be a triangle, the body is said to be a triangular prism; if square, a quadrangular one, &c.

From the genesis of the prism, it is evident it has two equal and opposite bases, and it is terminated by as many parallelograms as the base consists of sides: and that all the sections of a prism parallel to its base are equal. Every triangular prism may be divided into three equal pyramids.

To measure the surface of any prism, find the area of each side, whether a triangle, parallelogram, or other rectilinear figure, as directed under these articles, and the sum of all these, taken together, is the whole superfices of the prism. The solid content of a given prism may be found thus: let the area of the base of the prism be measured, as directed under the article MENSURATION; and let this area be multiplied by the height of the prism, and the product will give the solid content of the prism.

PRISM, in dioptrics, a triangular glass-prism, much used in experiments about the nature of light and colours. See OPTICS.

PRISTIS, the *saw-fish*, in natural history, a genus of fishes of the order Cartilaginei. It may be with more propriety considered as a species of the squalus, or shark, and as such is regarded by Shaw. The saw-fish inhabits the Mediterranean, and was known to the Greeks and Romans by the name of pristis. It grows to the length of sixteen feet, and the general length of the snout is about one third of that of the whole fish. There are three varieties, in which the difference is confined to the size and the snout.

PRIVATEERS, in maritime affairs, a kind of private ships of war, fitted out by private persons at their own expense; who have leave granted them to keep what they can take from the enemy, allowing the Admiral his share.

PRIVY *council*, is the principal council belonging to the King, and is generally called by way of eminence the council. Privy Counsellors are made, by the King's nomination, without either patent or grant; and on taking the necessary oaths they become immediately Privy Counsellors, during the life of the King that chooses them, but subject to removal at his discretion. No inconvenience now arises from the extension of the number of the Privy Council, as those only attend who are especially summoned for that particular occasion.

PRIZE, in maritime affairs, a vessel taken at sea from the enemies of a state, or from pirates; and that either by a man-of-war, a privateer, &c. having a commission for that purpose. Vessels are looked on as prize, if they fight under any other standard than that of the state from which they have their commission; if they have no charter-party, invoice, or bill of lading a-board; if loaded with effects belonging to the King's enemies, or with contraband goods. Those of the King's subjects recovered from the enemy, after remaining twenty-four hours in their hands, are deemed lawful prize. Vessels that refuse to strike may be constrained; and if they make resistance and fight, become lawful prize, if taken. If ships of war, the prizes are to be divided among the officers, seamen, &c. as his Majesty shall appoint by proclamation; but among privateers, the division is according to the agreement between the owner. By statute 13 George II. c. 4. Judges and officers, failing of their duty, in respect to the condemnation of prizes, forfeit 500*l.* with full costs of suits; one moiety to the King, and the other to the informer.

PROBABILITY is nothing but the appearance of the agreement or disagreement of two ideas, by the intervention of proofs whose connections is not constant and immutable, or is not perceived to be so; but is, or appears for the most part to be so;

and is enough to induce the mind to judge the proposition to be true or false, rather than the contrary.

Of probability there are degrees from the neighbourhood of certainty and demonstration, quite down to improbability and unlikeness, even to the confines of impossibility; and also degrees of assent, from certain knowledge, and, what is next to it, full assurance and confidence, quite down to conjecture, doubt, distrust, and disbelief. That proposition then is probable for which there are arguments, or proofs, to make it pass or be received for true. Probability being then to supply the defect of our knowledge, is always conversant about a thing whereof we have no certainty, but only some inducements to receive it for true. The grounds of it are, in short, these two following: First, the conformity of any thing with our own knowledge, experience, or observation. Secondly, the testimony of others vouching their observation and experience. In the testimony of others, is to be considered, 1. the number; 2. the integrity; 3. the skill of the witnesses; 4. the design of the author, if it be a testimony cited out of a book; 5. the consistency of the parts and circumstances of the relation; 6. contrary testimonies. The mind, before it rationally assents or dissents to any probable proposition, ought to examine all the grounds of probability, and see how they make more or less, for or against it; and, upon a due balancing the whole, reject or receive it, with a more or less firm assent, according to the preponderance of the greater grounds of probability, on one side, or the other.

Probability *of an event*, in the Doctrine of Chances, is the ratio of the number of chances by which the event may happen, to the number by which it may both happen and fail. So that, if there be constituted a fraction, of which the numerator is the number of chances for the events happening, and the denominator the number for both happening and failing, that fraction will properly express the value of the probability of the event's happening. Thus, if an event have 3 chances for happening, and 2 for failing, the sum of which being 5, the fraction $\frac{3}{5}$ will fitly represent the probability of its happening, and may be taken to be the measure of it. The same thing may be said of the probability of failing, which will likewise be measured by a fraction, whose numerator is the number of chances by which it may fail, and its denominator the

whole number of chances [illegible] pening and failing: so the probability [illegible] the failing of the above [illegible] chances to fail, and 5 [illegible] expressed or measured by the fraction [illegible]

Hence, if there be added together [illegible] fractions which express the probability [illegible] both happening and failing, [illegible] always be equal to unity, or 1, [illegible] sum of their numerators will be [illegible] their common denominator. And [illegible] is a certainty that an event will either [illegible] pen or fail, it follows that a certainty, [illegible] may be considered as an infinite [illegible] degree of probability, is fitly represented by unity. See Chances; Life, [illegible]

PROBATE *of wills*, is the exhibiting and proving wills and testaments before the ecclesiastical judges, delegated by the bishop, who is ordinary of the place where the party dies.

By the stamp acts, a very heavy duty is now payable upon these instruments, and a man can entitle himself to personal property only by means of a probate; that is, by having proved the will.

PROBLEM, in logic, a proposition that neither appears absolutely true or false, and, consequently, may be asserted either in the affirmative or negative. A logical or dialectical problem, according to the schoolmen, consists of two parts; a subject, about which the doubt is raised; and a predicate or attribute, which is the thing doubted whether it be true of the subject or not. Problems may be divided into physical, ethical, and metaphysical; physical, when it is doubted whether such and such properties belong to certain natural bodies; ethical, when the doubt is, whether or not it be proper to do or omit certain actions; and metaphysical, when the doubt relates to spirits, &c.

Problem, in geometry, is a proposition wherein some operation or construction is required; as, to divide a line or angle, erect or let fall perpendiculars, &c. A problem is said to consist of three parts; the proposition, which expresses what is to be done; the solution, wherein the several steps whereby the thing required is to be effected, are rehearsed in order; and, lastly, the demonstration, wherein is shown, that by doing the several things prescribed in the solution, the thing required is obtained.

Problem, in algebra, is a question or proposition which requires some unknown truth to be investigated, and the truth of

discovery demonstrated. So that a ...lem is to find a theorem.

...ROBLEM, *Kepler's*, in astronomy, is the ...rmining a planet's place from the time; ...alled from Kepler, who first proposed ... It was this, to find the position of a ...t line, which, passing through one of ... foci of an ellipsis, shall cut off an area ...cribed by its motion, which shall be in ... given proportion to the whole area of ... ellipsis.

The proposer knew no way of solving the ...oblem but by an indirect method; but ...r Isaac Newton, Dr. Keill, &c. have ...ce solved it directly and geometrically, ...veral ways.

... PROBLEM, *Deliacal*, or a problem for ...nding two mean proportionals between ...wo given lines, in geometry, is the doubling ... the cube; it was so called from the ...eople of Delos, who, upon consulting ...he oracles for a remedy against a plague, were answered, that the plague should cease when Apollo's altar, which was in form of a cube, should be doubled. See CUBE.

PROCEDENDO, is a writ which lies where a cause is removed out of an inferior to a superior court.

PROCELLARIA, the *petrel*, in natural history, a genus of birds of the order Anseres. Generic character: bill strait, but hooked at the end; nostrils generally contained in one tube, at the base of the bill; legs naked a little above the knee; back toe little more than a spur. There are twenty-three species, of which the following are the principal.

P. gigantea, or the giant petrel, is more than three feet long, and about seven wide These birds are often seen sailing just above the water without moving their wings for a long time together, and, being particularly alert on the approach of storms, often fill the mariner with apprehension and alarm. They abound most in southern latitudes and though their principal food is fish, devour also the putrid carcasses of seals and whales.

P. capensis, or the pintado petrel, abounds about the coasts of the Cape of Good Hope. These birds are about the size of the kittiwake gull, and are often observed in such numbers that many hundreds have been taken in one night. They are often taken with a rod and line by a hook baited with lard. They frequently discharge oil from their nostrils on those who hold them, spurting it in their faces with great violence.

P. glacialis, or the fulmar petrel, weighs nearly a pound and a half, and is found in the northern coasts of this island, and thence even beyond Iceland and Greenland, where the natives use it for food, though its flesh is highly offensive to those not used to it. The fat is burnt in their lamps. These birds subsist chiefly on fish, but often banquet on the carcases of whales, particularly the fat parts, which they afterwards eject from their stomachs into the mouths of their young. They often spurt it in the faces of their enemies and exhibit indeed no other mode of resistance. They are stated to be so amazingly fat, that, on being passed through the hands with great compression, the fat flows off like oil.

P. puffinus, or the shear water petrel, is smaller than the last. These birds are found in vast numbers in the Orkneys, where they are highly valued for their feathers as well as flesh. They are, in some places salted and barrelled, especially in the Isle of Man. In Denmark they sometimes reside in rabbit burrows. See Aves, Plate XII. fig. 5.

P. pelagica, or the stormy petrel, is of the size of a swallow and rarely seen but at sea, and in tempestuous weather numbers are observed frequently following, as if for shelter, in the wakes of vessels. They dive sometimes for half an hour together, and live principally upon fish, but will eat a variety of offal thrown from ships. In the Ferro Islands they are so astonishingly fat that the natives are stated to use them as candles after drawing a wick through their bodies. See Aves, Plate XII. fig. 6.

PROCESS, in law, is the manner of proceeding in every cause, being the writs and precepts that proceed, or go forth upon the original upon every action, being either original or judicial.

PROCKIA, in botany, a genus of the Polyandria Monogynia class and order Natural order of Rosaceæ, Jussieu. Essential character: calyx, three-leaved, besides two-leaflets at the base; corolla none; berry five cornered, many seeded. There is but one species, *viz.* P. crucis.

PROCYON, in astronomy, a fixed star of the second magnitude in the constellation, called canis minor.

PRODUCING, in geometry, signifies the drawing out a line further, till it have any assigned length.

PRODUCT, in arithmetic and geometry, the factum of two or more numbers, or lines, &c. into one another: thus 5 × 4

$= 20$, the product required. In lines it is always (and in numbers sometimes) called the rectangle between the two lines, or numbers, multiplied by one another.

PROFILE, in architecture, the draught of a building, fortification, &c. wherein are expressed the several heights, widths, and thicknesses, such as they would appear, were the building cut down perpendicularly from the roof to the foundation.

PROFILE also denotes the outline of a figure, building, member of architecture, &c. Hence profiling sometimes denotes designing or describing the member with a rule, compass, &c.

PROFILE, in sculpture and painting, denotes a head, portrait, &c. when represented side-ways, or in a side view. On almost all medals, faces are represented in profile.

PROGNOSTICS, among physicians, signifies a judgment concerning the event of a disease, as whether it shall end in life or death, be short or long, mild or malignant, &c.

PROGRESSION, in mathematics, is either arithmetical or geometrical. Continued arithmetic proportion, where the terms do increase and decrease by equal differences, is called arithmetic progression.

$$\text{thus}\left\{\begin{array}{l} a,\ a+b\ a+2b\ a+3b,\ \text{\&c. increasing} \\ a,\ a-b\ a-2b\ a-3b,\ \text{\&c. decreasing}\end{array}\right\}\text{ by the difference } d.$$

$$\text{In numbers}\left\{\begin{array}{l} 2,\ 4,\ 6,\ 8,\ 10,\ \text{\&c. increasing} \\ 10,\ 8,\ 6,\ 4,\ 2,\ \text{\&c. decreasing}\end{array}\right\}\text{ by the difference } 2.$$

But since this progression is only a compound of two series, viz.

$$\text{of}\left\{\begin{array}{llllll} \text{Equals} & a, & a, & a, & a, & a, \\ \text{Arith. proportionals} & 0, & \pm b, & \pm 2b, & \pm 3b, & \pm 4b,\end{array}\right\}\text{ \&c.}$$

If 1, 3, 5, 7, 9, &c. a, $a+b$, $a+2b$, $a+3b$, &c. a, $a-b$, $a-2b$, $a-3b$, &c, are in arithmetical progression. Hence it is manifest, that if a be the first term and $a+b$ the second, $a+2b$ is the third, $a+3b$ the fourth, &c. and $a+\overline{n-1}.b$ the n^{th} or last term.

"The sum of a series of quantities in arithmetical progression is found by multiplying the sum of the first and last terms by half the number of terms."

Let a be the first term, b the common difference, n the number of terms, and s the sum of the series: Then,

$$a\ +\overline{a+b}\ +\overline{a+2b}\ldots\overline{a+\overline{n-1}.a}=s, \text{ or,}$$

$$\overline{a+\overline{n-1}.b}+\overline{a+\overline{n-2}.b}+\overline{a+\overline{n-3}.b}\ldots+a=s.$$

Sum, $\overline{2a+\overline{n-1}.b}+\overline{2a+\overline{n-1}.b}+\overline{2a+\overline{n-1}.b}$ + &c. to n terms, $=2s$,

$$\text{or, } \overline{2a+\overline{n-1}.b}\times n=2s.$$

$$\text{and } s=\overline{2a+\overline{n-1}.b}\times\frac{n}{2}.$$

Any three of the quantities s, a, n, b, being given, the fourth may be found from the equation $s=\overline{2a+\overline{n-1}.b}\times\frac{n}{2}$.

Ex. 1. To find the sum of 18 terms of the series 1, 3, 5, 7, &c.

Here $a=1$, $b=2$, $n=18$; therefore, $s=\overline{2+34}\times 9=324$.

Ex. 2. Required the sum of 9 terms of the series 11, 9, 7, 5, &c.

In this case $a=11$, $b=-2$, $n=9$; therefore $s=\overline{22-16}\times\frac{9}{2}=6\times\frac{9}{2}=27$.

Ex. If the first term of an arithmetical progression be 14, and the sum of 8 terms be 28, what is the common difference?

$$\text{Since } \overline{2a+\overline{n-1}.b}\times\frac{n}{2}=s,$$

$$2a+\overline{n-1}.b\times\frac{2s}{n}$$

$$\overline{n-1}.b=\frac{2s}{n}2-a=\frac{2s-2an}{n};$$

therefore, $b=\dfrac{2s-2an}{n.\overline{n-1}}$. In the case proposed, $s=28$, $a=14$, $n=8$; therefore,

$$b=\frac{56-224}{8\times 7}=\frac{7-28}{7}=-3.$$

Hence, the series is 14, 11, 8, 5, &c.

PROGRESSION *geometrical*. Quantities are said to be in geometrical progression, or continual proportion, when the first is to the second, as the second to the third, and as the third to the fourth, &c. that is, when every succeeding term is a certain multiple, or part of the preceding term. If a be the first term, and ar the second, the series will be a, ar, ar^2, ar^3, ar^4, &c. For $a : ar :: ar : ar^2 :: ar^2 : ar^3$, &c.

The constant multiplier is called the common ratio, and it may be found by dividing the second term by the first.

"If quantities be in geometrical progression, their differences are in geometrical progression."

Let a, ar, ar^2, ar^3, ar^4, &c. be the quantities; their differences, $ar-a$, ar^2-ar, $ar^3-ar^2-ar^4-ar^3$, &c. form a geometrical progression, whose first term is $ar-a$, and common ratio r.

"Quantities in geometrical progression are proportional to their differences."

For $a : ar :: ar-a : ar^2-ar :: ar^2-ar : ar^3-ar^2$, &c.

"In any geometrical progression, the first term is to the third, as the square of the first to the square of the second."

Let a, ar, ar^2, &c. be the progression; then $a : ar^2 :: a^2 : a^2r^2$.

Hence it appears, that the duplicate ratio of two quantities (Euc. Def. 10. 5), is the ratio of their squares.

In the same manner it may be shown, that the first term is to the $\overline{n+1}^{th}$ term, as the first raised to the n^{th} power, to the second raised to the same power.

"If any terms be taken at equal intervals in a geometrical progression, they will be in geometrical progression."

Let $a, ar \ldots ar^n \ldots\ldots ar^{2n} \ldots\ldots ar^{3n} \ldots\ldots$ &c. be the progression, then a, ar^n, ar^{2n}, ar^{3n}, &c. are at the interval of n terms, and form a geometrical progression, whose common ratio is r^n.

"If the two extremes, and the number of terms in a geometrical progression be given, the means may be found."

Let a and b be the extremes, n the number of terms, and r the common ratio; then the progression is $a, ar, ar^2, ar^3 \ldots ar^{n-1}$; and since b is the last term, $ar^{n-1}=b$, and $r^{n-1}=\frac{b}{a}$; therefore $r=\left.\frac{b}{a}\right|^{\frac{1}{n-1}}$; and r being thus known, the terms of the progression ar, ar^2, ar^3, &c. are known.

"To find the sum of a series of quantities in geometrical progression, subtract the first term from the product of the last term and common ratio, and divide the remainder by the difference between the common ratio and unity."

Let a be the first term, r the common ratio, n the number of terms, y the last term, and s the sum of the series:

Then $a+ar+ar^2\ldots+ar^{n-2}+ar^{n-1}=s$; and multiplying both sides by r,

$$ar+ar^2+ar^3\ldots+ar^{n-1}+ar^n=rs$$

$$\text{Sub. } a+ar+ar^2+ar^3\ldots+ar^{n-1} \qquad =s$$

$$\text{Rem. } -a+ar^n=rs-s=\overline{r-1}\times s$$

or, $s=\frac{ar^n-a}{r-1}=\frac{ry-a}{r-1}$.

From the equation $s=\frac{ry-a}{r-1}$, any three of the quantities, s, r, y, a, being given, the fourth may be found. When r is a proper fraction, as n increases, the value of r^n, or of ar^n, decreases, and when n is increased without limit, ar^n becomes less, with respect to a, than any magnitude that can be assigned; and therefore $s=\frac{-a}{r-1}=\frac{a}{1-r}$.

This quantity $\frac{a}{1-r}$, which we call the sum of the series, is the limit to which the sum of the terms approaches, but never actually attains; it is, however, the true representative of the series continued *sine fine*; for this series arises from the division of a by $1-r$; and therefore $\frac{a}{1-r}$ may, without error, be substituted for it.

Ex. 1. To find the sum of 20 terms of the series, 1, 2, 4, 8, &c.

Here $a=1$, $r=2$, $n=20$; therefore,

$$s=\frac{1\times2^{20}-1}{2-1}=2^{20}-1.$$

Ex. 2. Required the sum of 12 terms of the series 64, 16, 4, &c.

Here $a=64$, $r=\frac{1}{4}$, $n=12$, therefore,

$$s=\frac{\frac{64}{4^{12}}-64}{\frac{1}{4}-1}=\frac{64\times4^{12}-64}{4^{12}-4^{11}}=\frac{64}{4^{11}}\times\frac{4^{12}-1}{4-1}.$$

Ex. 3. Required the sum of 12 terms of the series 1, -3, 9, -27, &c.

In this case, $a=1$, $r=-3$, $n=12$;

therefore, $s=\frac{\overline{-3}|^{12}-1}{-3-1}=-\frac{3^{12}-1}{4}$.

Ex. 4. To find the sum of the series $1-\frac{1}{2}+\frac{1}{4}-\frac{1}{8}+$ &c. *in infinitum*.

Here $a=1$, $r=-\frac{1}{2}$; therefore, (Art. 224),

$$s=\frac{1}{1+\frac{1}{2}}=\frac{2}{3}.$$

It may be observed, in connection with this subject, that the recurring decimals are quantities in geometrical progression, where $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, &c. is the common ratio, according as one, two, three, &c. figures recur; and the vulgar fraction, corresponding to such a decimal, is found by summing the series.

Ex. 5. Required the vulgar fraction corresponding to the decimal .123123123, &c.

Let .123123,123, &c. $=s$; then, multiply both sides by 1000; and 123.123123123,

&c. $= 1000s$, and by subtracting the former equation from the latter, $123 = 999s$; therefore $s = \frac{123}{999} = \frac{41}{333}$.

PROHIBITION, in law, is a writ properly issuing only out of the Court of King's Bench, being the King's prerogative writ; but, for the furtherance of justice, it may now also be had in some cases out of the Court of Chancery, Common Pleas, or Exchequer, directed to the judge and parties of a suit in an inferior court, commanding them to cease from the prosecution thereof, upon a suggestion, that either the cause originally, or some collateral matter arising therein, does not belong to that jurisdiction, but the cognizance of some other court. Upon the court being satisfied that the matter alleged by the suggestion is sufficient, the writ of prohibition immediately issues.

PROJECTILES, are such bodies as being put in a violent motion by any great force, are then cast off or let go from the place where they received their quantity of motion; as a stone thrown from a sling, an arrow from a bow, a bullet from a gun, &c. It is usually taken for granted, by those who treat of the motion of projectiles, that the force of gravity near the earth's surface is every where the same, and acts in parallel directions; and that the effect of the air's resistance upon very heavy bodies, such as bombs and cannon-balls, is too small to be taken into consideration.

Sir Isaac Newton has shown, that the gravity of bodies which are above the superficies of the earth, is reciprocally as the squares of their distances from its centre; but the theorems concerning the descent of heavy bodies, demonstrated by Gallileo, and Huygens, and others, are built upon this foundation, that the action of gravity is the same at all distances; and the consequences of this hypothesis are found to be very nearly agreeable to experience. For it is obvious, that the error arising from the supposition of gravity's acting uniformly, and in parallel lines, must be exceedingly small; because even the greatest distance of a projectile above the surface of the earth, is inconsiderable, in comparison of its distance from the centre, to which the gravitation tends. But then, on the other hand, it is very certain, that the resistance of the air to very swift motions, is much greater than it has been commonly represented. Nevertheless, (in the application of this doctrine to gunnery) if the amplitude of the projection, answering to one given elevation, be first found by experiment (which we suppose) the amplitudes in all other cases, where the elevations and velocities do not very much differ from the first, may be determined, to a sufficient degree of exactness, from the foregoing hypothesis; because, in all such cases, the effects of the resistance will be nearly as the amplitudes themselves; and were they accurately so, the proportions of the amplitudes, at different elevations, would then be the very same as in vacuo.

Now, in order to form a clear idea of the subject here proposed, the path of every projectile is to be considered as depending on two different forces; that is to say, on the impellant force, whereby the motion is first begun, (and would be continued in a right line) and on the force of gravity, by which the projectile, during the whole time of its flight, is continually urged downwards, and made to deviate more and more from its first direction. As whatever relates to the track and flight of a projectile, or ball, (neglecting the resistance of the air) is to be determined from the action of these two forces, it will be proper, before we proceed to consider their joint effects, to premise something concerning the nature of the motion produced by each, when supposed to act alone, independently of the other; to which end we have premised the two following lemmata.

Lemma I. Every body, after the impressed force whereby it is put in motion ceases to act, continues to move uniformly in a right line; unless it be interrupted by some other force or impediment.

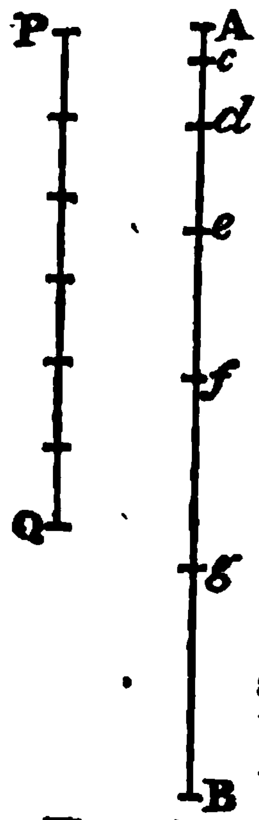
This is a law of nature, and has its demonstration from experience and matter of fact.

Corollary. It follows from hence, that a ball, after leaving the mouth of the piece, would continue to move along the line of its first direction, and describe spaces therein proportional to the times of their description, were it not for the action of gravity; whereby the direction is changed, and the motion interrupted.

Lemma II. The motion, or velocity, acquired by a ball, in freely descending from rest, by the force of an uniform gravity, is as the time of the descent; and the space fallen through, as the square of that time.

The first part of this lemma is extremely obvious: for since every motion is proportional to the force whereby it is ge-

nerated, that generated by the force of an uniform gravity, must be as the time of the descent; because the whole effort of such a force is proportional to the time of its action; that is, as the time of the descent.



To demonstrate that the distances descended are proportional to the squares of the times, let the time of falling through any proposed distance A B, be represented by the right line P Q; which conceive to be divided into an indefinite number of very small, equal, particles, represented each, by the symbol m; and let the distance descended in the first of them be A c; in the second $c\,d$; in the third $d\,e$; and so on.

Then the velocity acquired being always as the time from the beginning of the descent, it will at the middle of the first of the said particles be represented by one-half m; at the middle of the second, by $1\frac{1}{2}$ m; at the middle of the third, by $3\frac{1}{2}$ m, &c. which values constitute the series $\frac{m}{2}, \frac{3m}{2}, \frac{5m}{2}, \frac{7m}{2}, \frac{9m}{2}$, &c.

But since the velocity, at the middle of any one of the said particles of time, is an exact mean between the velocities of the two extremes thereof, the corresponding particle of the distance, A B, may be therefore considered as described with that mean velocity: and so, the spaces A c, $c\,d$, $d\,e$, $e\,f$, &c. being respectively equal to the above-mentioned quantities $\frac{m}{2}, \frac{3m}{2}, \frac{5m}{2}, \frac{7m}{2}$, &c. it follows, by the continual addition of these, that the space A c, A d, A e, A f, &c. fallen through from the beginning, will be expressed by $\frac{m}{2}, \frac{4m}{2}, \frac{9m}{2}, \frac{16m}{2}, \frac{25m}{2}$, &c. which are evidently to one another in proportion, as, 1, 4, 9, 16, 25, &c. that is, as the squares of the times. *Q. E. D.*

Corollary. Seeing the velocity acquired in any number (n) of the aforesaid equal particles of time (measured by the space that would be described in one single particle) is represented by (n) times m, or nm; it will therefore be, as one particle of time, is to n such particles, so is nm, the said distance answering to the former time, to the distance, n^2m, corresponding to the latter, with the same celerity acquired at the end of the said n particles. Whence it appears that the space $\frac{n^2m}{2}$ (found above) through which the ball falls, in any given time n, is just the half of that (n^2m) which might be uniformly described with the last, or greatest celerity in the same time.

Scholium. It is found by experiment, that any heavy body, near the earth's surface (where the force of gravity may be considered as uniform) descends about 16 feet from rest, in the first second of time. Therefore, as the distances fallen through, are proved above to be in proportion as the squares of the time. It follows that, as the square of one second is to the square of any given number of seconds, so is 16 feet to the number of feet, a heavy body will freely descend in the said number of seconds. Whence the number of feet descended in any given time will be found, by multiplying the square of the number of seconds by 16. Thus the distance descended in 2, 3, 4, 5, &c. seconds, will appear to be 64, 144, 256, 400 feet, &c. respectively. Moreover, from hence, the time of the descent through any given distance will be obtained, by dividing the said distance in feet, by 16, and extracting the square root of the quotient; or, which comes to the same thing, by extracting the square root of the whole distance, and then taking one-half of that root for the number of seconds required. Thus, if the distance be supposed 2,640 feet; then, by either of the two ways, the time of the descent will come out 12.84, or 12.50 seconds.

It appears also (from the corol.) that the velocity per second (in feet) at the end of the fall, will be determined by multiplying the number of seconds in the fall by 32. Thus it is found that a ball, at the end of ten seconds, has acquired a velocity of 320 feet per second. After the same manner, by having any two of the four following quantities, *viz.* the force, the times, the velocity, and distance, the other two may be determined: for let the space freely descended by a ball, in the first second of time (which is as the accelerating force) be denoted by F; also let T denote the number of seconds wherein any distance, D, is descended; and let V be the velocity per second, at the end of the descent; then will

$$V = 2\,F\,T = 2\sqrt{F\,D} = \frac{2\,D}{T}$$

$$T = \sqrt{\frac{D}{F}} = \frac{V}{2F} = \frac{2D}{V}$$

$$D = FTT = \frac{VV}{4F} = \frac{TV}{2}$$

$$F = \frac{D}{TT} = \frac{V}{2T} = \frac{VV}{4D}$$

All which equations are very easily deduced from the two original ones, D = F T T, and V = 2 F T, already demonstrated; the former in the proposition itself, and the latter in the corollary to it; by which it appears that the measure of the velocity at the end of the first second is 2 F; whence the velocity (V) at the end of (T) seconds must consequently be expressed by 2 F × T or 2 F T.

Theorem 1. A projected body, whose line of direction is parallel to the plane of the horizon, describes by its fall a parabola. If the heavy body is thrown by any extrinsical force, as that of a gun or the like, from the point A, (Plate Perspective, &c. fig. 7.) so that the direction of its projection is the horizontal line, A D; the path of this heavy body will be a semi-parabola. For if the air did not resist it, nor was it acted on by its gravity, the projectile would proceed with an equable motion, always in the same direction; and the times wherein the parts of space, A B, A C, A D, A E, were passed over, would be as the spaces, A B, A C, A D, &c. respectively. Now if the force of gravity is supposed to take place, and to act in the same tenour, as if the heavy body were not impelled by any extrinsical force, that body would constantly decline from the right line, A E; and the spaces of descent, or the deviations from the horizontal line, A E, will be the same as if it had fallen perpendicularly. Wherefore if the body falling perpendicularly by the force of its gravity, passed over the space A K in the time A B descended through A L, in the time A C, and through A M in the time A D; the spaces, A K, A L, A M, will be as the squares of the times, that is, as the squares of the right lines, A B, A C, A D, &c. or K F, L G, M H. But since the impetus in the direction parallel to the horizon always remains the same (for the force of gravity, that only solicits the body downwards, is not in the least contrary to it); the body will be equally promoted forwards in the direction parallel to the plane of the horizon, as if there was no gravity at all. Wherefore, since in the time, A B, the body passes over a space equal to A B; but being compelled by the force of gravity, it declines from the right line, A B, through a space equal to A K; and B F being equal and parallel to A K, at the end of the time, A B, the body will be in F, so in the same manner, at the end of the time, A E, the body will be in I; and the path of the projectile will be in the curve, A F G H I; but because the squares of the right lines, K F, L G, M H, N I, are proportionable to the abscisses, A K, A L, A M, A N. The curve, A F G H I, will be a semi-parabola. The path, therefore, of a heavy body projected according to the direction, A E, will be a semi-parabolical curve, *Q E D.*

Theorem 2. The curve line, that is described by a heavy body projected obliquely and upwards, according to any direction, is a parabola.

Let A F (fig. 8) be the direction of projection, any ways inclined to the horizon, gravity being supposed not to act, the moving body would always continue its motion in the same right line, and would describe the spaces A B, A C, A D, &c. proportional to the times. But by the action of gravity it is compelled continually to decline from the path A F, and to move in a curve, which will be a parabola. Let us suppose the heavy body falling perpendicularly in the time A B, through the space A Q, and in the time A C, through the space A R, &c. The spaces A Q, A R, A S, will be as the squares of the times, or as the squares of A B, A C, A D. It is manifest from what was demonstrated in the last theorem, that if in the perpendicular B G, there is taken B M = A Q and the parallelogram be completed, the place of the heavy body at the end of the time A B, will be M, and so of the rest; and all the deviations B M, &c. from the right line A F, arising from the times, will be equal to the spaces A Q, A R, A S, which are as the squares of the right lines A B, A C, A D. Through A draw the horizontal right line A P, meeting the path of the projectile in P. From P raise the perpendicular P E, meeting the line of direction in E; and by reason the triangles A B G, A C H, &c. are equiangular, the squares of the right lines A B, A C, &c. will be proportionable to the squares of A G, A H, &c. so that the deviations B M, C N, &c. will be proportionable to the squares of the right lines A G, A H, &c. Let

the line L be a third proportional to E P and A P; and it will be (by 17 El. 6) $L \times EP = AP q$, but $AP q. : AG q. :: EP : BM :: L \times EP : L \times BM$; whence since it is $L \times EP = AP q.$ it will be $L \times BM = AG q$. In like manner it will be $L \times CN = AH q$, &c. But because it is $BG : AG :: (EP : AP ::$ by hypothesis) $AP : L$; it will be $L \times BG = AG \times AP = AG \times AG + AG \times GP = AG q. + AG \times GP$. But it has been shown that it is $L \times BM = AG q$, wherefore it will be $L \times BG - L \times BM = AG \times GP$, that is, $L \times MG = AG \times GP$. By the same way of reasoning it will be $L \times NH = AH \times HP$, &c. Wherefore the rectangle under M G and L, will be equal to the square of A G, which is the property of the parabola; and so the curve A M N O P K, wherein the projectile is moved, will be a parabola.

Cor. 1. Hence the right line L is the latus rectum or parameter of the parabola, that belongs to its axis.

Cor. 2. Let $AH = HP$, and it will be $L \times CN = AH q. = L \times NH$, whence it will be $NH = CN$; and consequently the right line A F being the line of direction of the projectile, will be a tangent to the parabola.

Cor. 3. If a heavy body be projected downwards, in a direction oblique to the horizon; the path of the projectile will be a parabola.

Theorem 3. The impetus of a projected body in different parts of the parabola, are as the portions of the tangents intercepted between two right lines parallel to the axis; that is, the impetus of the body projected in the points A and B (fig. 9) to which A D, and B E are tangents, will be as C D, and E B, the portions of the tangents intercepted between two right lines C B, and D E parallel to the axis.

We have here treated the path of a projected body as an exact parabola, though from the resistance of the air, the line of a projectile is not exactly parabolical, but rather a kind of hyperbola; which, if considered and applied to practice, would render the computations far more operose, and the very small difference (as experience shows in heavy shot) would, in a great measure, lessen the elegancy of the demonstrations given by accounting for it; since the common rules are sufficiently exact, and easy for practice.

PROJECTION, in mechanics, the act of communicating motion to a body, from thence called projectile. In perspective, projection is the appearance or representation of an object on the perspective plane. The projection of the sphere is either orthographic, or stereographic. The former, or orthographic projection, supposes the eye placed at an infinite distance; whereas, in the stereographic projection, it is supposed to be only 90 degrees distant from the primitive circle, or placed in its pole, and thence viewing the circles on the sphere. The primitive circle is that great circle which limits or bounds the representation or projection; and the place of the eye is called the projecting point.

PROLATE, in geometry, an epithet applied to a spheroid produced by the revolution of a semi-ellipses about its larger diameter.

PROLEGOMENA, in philology, certain preparatory observations or discourses prefixed to a book, &c. containing something necessary for the reader to be apprized of, to enable him the better to understand the book, or to enter deeper into the science, &c.

PROMISE, in law, is where, upon a valuable consideration, persons bind themselves by words to do or perform such a thing agreed on: it is in the nature of a verbal covenant, and wants only the solemnity of writing and sealing to make it absolutely the same. Yet for the breach of it the remedy is different; for instead of an action of covenant, there lies only an action upon the case, the damages whereof are to be estimated and determined by the jury. If there is no consideration it is void, and it is called a nude compact, or in Latin a *nudum pactum*.

PROMISSORY *note*. See BILLS *of Exchange*.

PRONOUN, *pronomen*, in grammar, a declinable part of speech, which being put instead of a noun, points out some person, or thing. See GRAMMAR.

PRONUNCIATION, in grammar, the manner of articulating or sounding the words of a language. Pronunciation makes much the most difficult part of a written grammar; in regard that a book expressing itself to the eyes, in a matter that wholly concerns the ears, seems next akin to that of teaching the blind to distinguish colours; hence it is that there is no part so defective in grammar as that of the pronunciation, as the writer has frequently no term whereby to give the reader n idea of the sound he would express; f want of a proper term,

therefore, he substitutes a vicious and precarious one. To give a just idea of the pronunciation of a language, it seems necessary to fix as nearly as possible all the several sounds employed in the pronunciation of that language.

PRONUNCIATION is also used for the fifth and last part of rhetoric, which consists in varying and regulating the voice agreeably to the matter and words, so as most effectually to persuade and touch the hearers. It is much the same with what is otherwise called emphasis.

This emphasis is a considerable stress or force of voice, laid upon that word in a sentence by which the sense of the whole is regulated: thus, suppose you were asked, "are you determined to walk this day to London?" If the emphasis be placed on the word *you*, the answer may be, "yes, I go myself;" or "no, I shall send my son." Again, if it be placed on the word *walk*, the answer is, "yes, I am;" or "no, I shall ride;" if on the words *to-day*, then the answer is, "yes;" or "no, I shall go to-morrow:" and lastly, if the emphasis be placed on the word *London*, the answer may be, "no, I shall go to Richmond only."

Quintilian advises his pupils to study the principles of pronunciation under a comedian. There are three things which come under the pronunciation, *viz*, the memory, voice, and gesture.

PROOF, in arithmetic, an operation whereby the truth and justness of a calculation is examined and ascertained. The proper proof is always by the contrary rule: thus subtraction is the proof of addition, and multiplication of division; and *vice versa*.

PROOF, in military affairs, is a trial whether the piece will stand the quantity of powder allotted for that purpose.

PROPAGO, in botany, properly a slip, layer, or cutting of a vine or other tree.

PROPORTION. When two quantities are compared one with another, in respect of their greatness or smallness, the comparison is called ratio, reason, rate, or proportion; but when more than two quantities are compared, then the comparison is more usually called the proportion that they have to one another. The words ratio and proportion are frequently used promiscuously. When two quantities only are compared, the former term is called the antecedent, and the latter the consequent. The relation of two homogeneous quantities one to another, may be considered either, 1. By how much the one exceeds the other, which is called their difference. Thus 5 exceeds 3 by the difference 2. Or, 2. What part or parts one is of another, which is called ratio. Thus the ratio of 6 to 3 is $\frac{6}{3}=\frac{2}{1}$, or double; and the ratio of 3 to 6 is $\frac{3}{6}=\frac{1}{2}$, or subduple.

When two differences are equal, the terms that compose them are said to be arithmetically proportional. Thus suppose the term to be a and b, their difference d. If a be the last term, then $a+d=b$. And if a be the greatest, then $a-d=b$.

But when two ratios are equal, the terms that compose them are said to be geometrically proportional. For suppose a and b to be the terms of any ratio; if a be the least term, put $r=\frac{b}{a}$, then $ar=b$ by equal multiplication: but if b be the least term, put $r=\frac{a}{b}$, then $br=a$ by equal multiplication, and $\frac{a}{r}=b$ by equal division.

Thus the ratio of two quantities, or of two numbers, in geometrical proportion, is found by dividing the antecedent by the consequent, and the quotient is the exponent or denominator of the ratio.

If when four quantities are considered, you find that the first hath as much greatness or smallness in respect to the second, as the third hath in respect to the fourth: those four quantities are called proportionals, and are thus expressed.

As $\left\{\begin{matrix} A : B :: C : D \\ 8 : 2 :: 16 : 4 \end{matrix}\right\}$ that is, as $A=8$ contains $B=2$ four times, so $C=16$ contains $D=4$, four times; and therefore A has the same ratio to B as C has to D; and consequently these four quantities having equal ratios, are proportionals.

Proportion consists of three terms at least, whereof the second supplies the place of two.

When three magnitudes, A, B, C, are proportional, the first, A, has a duplicate ratio to the third, C, of that it hath to the second, B: but when four magnitudes, A, B, C, D, are proportional, the first, A, has a triplicate ratio to the fourth, D, of what it has to the second, B; and so always in order one more, as the proportion shall be extended.

Duplicate ratio is thus expressed, $\frac{A}{C}=\frac{A}{B}$ twice; that is, the ratio of A to C is duplicate of the ratio of A to B. For let $A=2$, $B=4$, $C=8$; then the ratio of 2 to 8 is

duplicate of the ratio of $2 = A$ to $B = 4$, or as the square of 2 to the square of 4.

Triplicate ratio is thus expressed, $\frac{A}{D} = \frac{A}{B}$ thrice; that is, the ratio of A again $= 2$, to $D = 16$, is triplicate of the ratio of $A = 2$ to $B = 4$, or as 8 the cube of 2, to 64 the cube of 4. Wherefore duplicate ratio is the proportion of squares, and triplicate that of cubes.

And the ratio of 2 to 8 is compounded of the ratio of that of 2 to 4, and of 4 to 8. From what has been said of the nature of ratio and proportion, the six ways of arguing, which are often used by mathematicians, will evidently follow.

1. Alternate proportion is the comparing of antecedent to antecedent, and consequent to consequent. As if $\left\{\begin{matrix} A : B :: C : D \\ 2 : 4 :: 8 : 16 \end{matrix}\right\}$ therefore alternately, or by permutation, as $\left\{\begin{matrix} A : C :: B : D \\ 2 : 8 :: 4 : 16 \end{matrix}\right\}$.

2. Inverse ratio, is when the consequent is taken as the antecedent, and so compared to the antecedent as the consequent. As $A : B :: C : D$; therefore inversely as $\left\{\begin{matrix} B : A :: D : C \\ 4 : 2 :: 16 : 8 \end{matrix}\right\}$.

3. Compound ratio, is when the antecedent and consequent, taken both as one, are compared to the consequent itself. As $A : B :: C : D$; therefore by composition, as $A + B : B :: C + D : D$: in numbers, as $2 + 4 = 6$, is to 4, so is $8 + 16 = 24$, to 16.

4. Divided ratio, is when the excess wherein the antecedent exceedeth the consequent is compared to the consequent. As $A : B :: C : D$; therefore by division $A - B : B :: C - D : D$ in numbers, as $16 : 8 :: 12 : 6$; therefore $16 - 8 = 8$, is to 8, so is $12 - 6 = 6$ to 6.

When of several quantities the difference or quotient of the first and second is the same with that of the second and third, they are said to be in a continued arithmetic or geometric proportion.

Thus $\left\{\begin{matrix} a, a+d, a+2d, a+3d, a+4d \\ a, a-d, a-2d, a-3d, a-4d \end{matrix}\right\}$ &c. is a series of continued arithmetical proportionals, whose common difference is d.

And $\left\{\begin{matrix} a, & ar, & arr, & arrr, & arrrr, & ar^5 \\ a, & \frac{a}{r}, & \frac{a}{rr}, & \frac{a}{rrr}, & \frac{a}{rrrr}, & \frac{a}{r^5} \end{matrix}\right\}$ &c. is a series of continued geometric proportionals, whose common multiplier is $\frac{r}{1}$ or $\frac{1}{r}$, or whose ratio is that of 1 to r, or r to 1.

Proportion *of figures*. To find the proportion that one rectangle hath to another, both length and breadth must be considered. For rectangles are to each other, as the products of their respective lengths multiplied by their breadths. Thus, if there be two rectangles, the former of which hath its length five feet, and its breadth three; and the latter hath its length eight feet, and its breadth four. Then the rectangles will be to each other as $3 \times 5 (= 15)$, is to 4×8 $(= 32)$; that is, as $15 : 32$, so that all the rectangles are to one another in a ratio compounded of that of their sides.

When rectangles have their sides proportionable, so that $\frac{AB}{8} :: \frac{EH}{4} :: \frac{AD}{4} : \frac{EF}{2}$, then is the rectangle A, to the rectangle B, in a duplicate proportion to the ratio of the sides. For the ratio of A to B, is compounded of the ratio of A B to E H, and of the ratio of A D to E F. And therefore the proportion of A to B, being compounded of equal ratios, must be duplicate of the ratio of their sides to each other; that is, duplicate of the ratio of A B : E H, or of A D : E F.

Hence all triangles, parallelograms, prisms, parallelopipeds, pyramids, cones, and cylinders, are to one another respectively compared, in a proportion compounded of that of their heights and bases. All triangles, and parallelograms, pyramids, prisms, and parallelopipeds; also all cones and cylinders, each kind compared among themselves; if they have equal altitudes, are in the same proportion as their bases; if they have equal bases, are as their heights.

For the bases, or heights, will severally be common efficients or multipliers; and therefore must make the products be in the same proportion as the multiplicand was before.

Thus, if the equal altitude of any two triangles, parallelopipeds, cones, &c. be called A, and their unequal bases B and D: then it will be as $B : D :: AB : AD$.

Proportion, *harmonic*, is when three terms are so disposed, that as the difference of the first and second: the difference of the second and third :: first : third; and they are said to be harmonically proportional. Thus, 10, 15, 30, are harmonically proportional. For as the difference of 10 and 15, is to the difference of 15 and 30, so is 10 to 30. Also 12, 6, 4, are harmo-

nically proportional; for 12 — 6 : 6 — 4 : : 12 : 4. So $h^2 + 3hn + 2n^2$, $h^2 + 2hn$, $h^2 + hn$, are harmonically proportional. For $hn + 2n^2 : hn :: h^2 + 3hn + 2n^2 : h^2 + hn$. Whence if the two first terms of an harmonic proportion be given, the third is readily found.

For if A, B, C, be harmonically proportional. Then $A - B : B - C :: A : C$, and $AC - BC = AB - AC$. Therefore $AB = 2A - B \times C$, and $BC = 2C - B \times A$. Consequently $C = \frac{AB}{2A - B}$, and $A = \frac{BC}{2C - B}$. Again, when four terms are so disposed, that as the difference of the 1st and 2d : the difference of the 3d and 4th : : 1st : 4th, they are also harmonically proportional. As 10, 16, 24, 60; for as 10 — 16 : 24 — 60 : : 10 : 60. Whence if the three first terms of such an harmonic proportional be given, the 4th is easily found.

For if a, b, c, d, be harmonic proportionals, then $a - b : c - d :: a : d$; and $ad - bd = ac - ad$, therefore $d = \frac{ac}{2a - b}$, and $a = \frac{bd}{2d - c}$.

If the terms of an harmonic proportion be continued, then it is called an harmonic progression. Thus, supposing

h, to be the 2d term,
d, the difference of the 1st and 2d

and that the 1st exceeds the 2d. The progression will be

$h + d$, h, $\frac{h^2 + hd}{h + 2d}$, $\frac{h^2 + hd}{h + 3d}$, $\frac{h^2 + hd}{h + 4d}$, $\frac{h^2 + hd}{h + 5d}$, &c. Whence, if out of a rank of harmonic proportionals, there be taken any series of equidistant terms, that series will be harmonically proportional. And this kind of proportion has several other properties common with arithmetic and geometric proportions.

When three terms are so disposed, that the difference of the 1st and 2d : difference of the 2d and 3d : : 3d : 1st, they are said to be in a contra-harmonic proportion. Thus, 6, 5, 3, and 12, 10, 4, are contra-harmonics. For 6 — 5 : 5 — 3 : : 3 : 6; and 12 — 10 : 10 — 4 : : 4 : 12. Or, supposing h greater than n, if the 2d term be greater than the 1st:

Then $hn + n^2$, $h^2 + n^2$, $h^2 + hn$, are contra-harmonics, for $hn - h^2 : n^2 - hn :: h^2 + hn : hn + n^2$.

But if the 1st term exceeds the 2d, then $h^2 + hn$, $h^2 + n^2$, $hn + n^2$, are contra-harmonics. For $hn^2 - n^2 : h^2 - hn :: hn + n^2 : h^2 + hn$.

PROPOSITION, in logic, part of an argument wherein some quality, either negative or positive, is attributed to a subject, as "God is just." While the comparing of our ideas is considered merely as the act of the mind, assembling them together, and joining or disjoining them according to the result of its perceptions, this operation is called judgment. But when these judgments are expressed in words, they then bear the name of propositions. Hence a proposition is a sentence expressing some judgment of the mind, whereby two or more ideas are affirmed to agree or disagree: and as our judgments include at least two ideas, one of which is affirmed or denied of the other; so a proposition must have terms corresponding to these ideas. The idea of which we affirm or deny, and of course the term expressing that idea, is called the subject of the proposition; and the idea affirmed or denied, as also the term answering to it, is called its predicate; thus in the proposition, God is omnipotent, God is the subject, it being of him that we affirm omnipotence; and omnipotent is the predicate, because we affirm the idea expressed by that word to belong to God.

PROPOSITION, in mathematics, is either some truth advanced and shown to be such by demonstration, or some operation proposed and its solution shown. If the proposition be deduced from several theoretical definitions compared together, it is called a theorem; if from a praxis, or series of operations, it is called a problem.

PROPOSITION, in poetry, the first part of a poem wherein the author proposes briefly, and in general, what he is to say in the body of his work. It should comprehend only the matter of the poem, that is the action and the persons that act. Horace prescribes modesty and simplicity in the proposition, and would not have the poet promise too much, nor raise in the reader too great ideas of what he is going to relate.

PROSERPINACA, in botany, a genus of the Triandria Trigynia class and order. Natural order of Inundatæ. Hydrocharides, Jussieu. Essential character: calyx three-parted, superior; corolla none; drupe with a three-celled nut. There is but one species, viz. P. palustris, a native of Virginia in marshes.

PROSODY, that part of grammar which

treats of the quantities and accents of syllables, and the manner of making verses. The English prosody turns chiefly on two things, numbers and rhyme.

PROSONOMASIA, a figure in rhetoric, whereby allusion is made to the likeness of a sound in several names or words.

PROSOPIS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx bell-shaped, five-toothed; stigma simple; legume linear, many-seeded. There is but one species, viz. P. spicigera; it is a native of most parts of the Coromandel coast, flowering during the cold season; the pod of this tree is the only part used; it is nearly an inch in circumference, and from six to twelve inches long; when ripe, it is brown and smooth, containing besides the seeds, a large quantity of a brown mealy substance, which the natives eat; it has a sweetish agreeable taste.

PROSOPOPŒIA, a figure in rhetoric, whereby we raise qualities, or things inanimate, into persons. This figure is divided into two parts: 1. when good and bad qualities, accidents, and things inanimate, are introduced as living and rational beings; as in the following verses of Milton:

——— Now gentle gales,
Fanning their odoriferous wings, dispense
Native perfumes; and whisper whence they stole
Those balmy spoils.———

The second part of this figure is when we give a voice to inanimate things, and make rocks, woods, rivers, buildings, &c. express the passions of rational creatures, as in the following lines of Spencer.

She foul blasphemous speeches forth did cast,
And bitter curses, horrible to tell,
That ev'n the temple wherein she was placed,
Did quake to hear, and nigh asunder burst!

PROSTATÆ. See ANATOMY.

PROTEA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Proteæ, Jussieu. Essential character: corolla four-cleft or four-petalled; anthers linear, inserted into the petals below the tip; calyx proper, none; nut one-seeded, superior. There are sixty-four species; these are all shrubs and natives of the Cape of Good Hope.

PROTECTION *of parliament*. See ARREST and PRIVILEGE.

PROTEST, in law, is where one openly affirms, that he does either not at all, or but conditionally, yield his consent to any act, or to the proceeding of a judge in court, wherein his jurisdiction is doubtful, or to answer upon his oath further than by law he is bound. It is also that act by which the holder of a foreign bill of exchange declares that such bill is dishonoured. Further, it is that act of a master, on his arrival, with his ship from parts beyond the seas, to save him and his owners harmless and indemnified from any damage sustained in the goods of her lading, on account of storms. See BILLS OF EXCHANGE and INSURANCE.

PROTESTANTS, a term now applied to all christians who in any country or of any sect dissent from the principles and discipline of the church of Rome. This name was first given to the following princes of the German Empire; John, Elector of Saxony; George, Elector of Brandenburg, for Franconia; Ernest and Francis, Dukes of Lunenburg, the Landgrave of Hesse, and the Prince of Anhalt. These princes, being seconded by thirteen imperial towns, viz. Strasbourg, Ulm, Nuremberg, Constance, Rottingen, Windseim, Memmingen, Nortlingen, Lindau, Kempten, Heilbron, Wissemberg, and St. Gall, solemnly *protested* against the decree of the Emperor Charles the Fifth, and the diet of Spires, by which it had been decreed to prohibit any further innovations in religion. This Protest was made in the year 1529; from which time all who have renounced, or never agreed to, the doctrines of the Romish church have been denominated Protestants. This class of christians consequently includes the Huguenots in France, the Refugees in Holland, the Presbyterians in Scotland, as well as the Episcopalians and Nonconformists in England; together with a numerous body of christians in America. The principal denominations of Protestants in England, are the Episcopalians or church of England, the Presbyterians, the Independents, and the Baptists, general and particular. These, however, have divided themselves into innumerable sects and parties; the principal of which are denominated Arians and Socinians, or, more properly speaking, Unitarians; Sabellians, Calvinists, Sublapsarians and Supralapsarians, Arminians, Baxterians, Antinomians,

Brownists, Pædobaptists, Quakers, Methodists, Universalists, Sabbaterians, Moravians, Sandemanians, and Swedenborgians. Concerning these, and other christian sects, the reader will find very impartial accounts, drawn up in a popular and perspicuous manner, and accompanied with many pious and sensible reflections on the nature and extent of christian candour, in the Rev. J. Evans's "Sketch of the Denominations of the Christian World, eleventh edition. But for more elaborate accounts of the christian sects, the reader is referred to Dr. Rees's Cyclopedia; the theological, as, indeed, every other, department of which is conducted in a manner every way worthy the literature of a country where the genuine principles of religious liberty are clearly understood, and extensively encouraged. The sects and parties into which the Protestant religion is divided, have furnished the Roman Catholics, on some occasions, with matter of triumph; asserting that the Protestant faith is deficient in the first mark or characteristic of a true church, viz. that of unity; and unbelievers have not neglected to avail themselves of this circumstance to vilify the christian religion altogether; as affording no sufficient data for religious truth, but engendering only strife, animosity, division, and bloodshed: and, it must be confessed, that when the enemies of the Protestant faith behold the rancour, the bigotry, and the malice of many sectaries, and particularly of those sects which are the most numerous and popular, they have but too much ground for their triumphs. When the spirit of Chillingworth shall have influenced the hearts, and directed the lives of all Protestants, their professions will be as consistent as their leading principles are rational and scriptural. That author addressing himself to a Romish writer, speaks of the religion of Protestants in the following terms. "Know then, Sir, that when I say the religion of Protestants is in prudence to be preferred before yours; as, on the one side, I do not understand by your religion the doctrine of Bellarmine or Baronius, or any other private man amongst you, nor the doctrine of the Sorbonne, or of the Jesuits, or of the Dominicans, or of any other particular company among you; but that wherein you all agree, the doctrine of the Council of Trent; so accordingly, on the other side, by the religion of Protestants I do not understand the doctrine of Luther, or Calvin, or Melancthon; nor the confession of Augsberg or Geneva; nor the catechism of Heidelberg, nor the articles of the church of England—no, nor the harmony of Protestant confessions; but that wherein they all agree, and which they all subscribe with a greater harmony, as a perfect rule of faith and action, that is, THE BIBLE! The Bible, I say, the Bible only, is the religion of Protestants. Whatsoever else they believe besides it, and the plain, irrefragable, indubitable consequences of it, well may they hold it as a matter of opinion; but as a matter of faith and religion, neither can they with coherence to their own grounds, believe it themselves, nor require belief of it of others, without most high and most schismatical presumption. I, for my part, after a long (and I verily believe and hope) impartial search of the true way to eternal happiness, do profess plainly, that I cannot find any rest for the sole of my foot, but upon this rock only. I see plainly, and with my own eyes, that there are popes against popes, and councils against councils; some fathers against other fathers, and some fathers against themselves; a consent of fathers of one age against consent of fathers of another age; traditive interpretations of scripture are pretended, but there are few or none to be found: no tradition but that of scripture can derive itself from the fountain; but may be plainly proved either to have been brought in, in such an age after Christ, or that in such an age it was not in. In a word, there is no sufficient certainty but that of scripture only for any considering man to build upon. This, therefore, and this only, I have reason to believe. This I will profess; according to this I will live; and for this, if there be occasion, I will not only willingly, but even gladly lose my life; though I should be sorry that christians should take it from me. Propose me any thing out of the book, and require whether I believe it or no, and seem it never so incomprehensible to human reason, I will subscribe it with hand and heart, as knowing no demonstration can be stronger than this: God hath said so, therefore it is true. In other things I will take no man's liberty of judging from him, neither shall any man take mine from me. I will think no man the worse man, nor the worse christian; I will love no man the less for differing in opinion from me. And what measure I mete to others, I expect from them again. I am fully assured that God does not, and therefore men ought not, to require any more of any man than this: to

believe the scripture to be God's word; to endeavour to find the true sense of it, and to live according to it."

Such are the genuine principles of Protestantism; such the spirit by which all christians ought to be actuated. Those men, who, calling themselves Protestants, are of a contrary spirit (and it is a lamentable fact that their number is daily increasing) are a disgrace to their profession, and bring dishonour on the common cause of christianity. Their devotion is enthusiasm, and their zeal madness; while their increasing number portends one of the greatest of all public calamities; threatening to rekindle the latent embers of persecution;—again to light up those fires which the united efforts of reason, philosophy, and the principles of rational religion have conspired to extinguish for ever. See Arminians, Presbyterians, Puritans, Reformation, and Roman Catholics.

PROTESTATION is a form in pleading, when one does not directly affirm or deny any thing that is alleged by another, or which he himself alleges.

PROTRACTOR is the name of an instrument used for protracting or laying down on paper the angles of a field, or other figure. The protractor is a small semi-circle of brass, or other solid matter, the limb or circumference of which is nicely divided into one hundred and eighty degrees: it serves not only to draw angles on paper, or any plane, but also to examine the extent of those already laid down. For this last purpose, let the small point in the centre of the protractor be placed above the angular point, and let the side coincide with one of the sides that contain the angle proposed; then the number of degrees cut off by the other side, computing on the protractor, will show the quantity of the angle that was to be measured. See Mensuration.

Protractors are now more usually made in the form of a parallelogram, and properly graduated at the upper edge. See Mathematical *Instruments*.

PROVIDENCE, the conduct and direction of the several parts of the universe, by a superior intelligent being.

PROVINCE, in law, means the circuit of an Archbishop's jurisdiction, which is subdivided into bishoprics. The ecclesiastical division of this kingdom is into two provinces; *viz.* Canterbury and York. Provincial constitutions, in this kingdom, were decrees made in the provincial synods, held under divers Archbishops of Canterbury.

PROVISO, in law, is a condition inserted in a deed, upon the observance of which the validity of the deed depends.

PROVOST *marshal*, an officer of the King's navy, who has charge of the King's prisoners taken at sea.

PROVOST, or Prevot, in the King's stables; his office is to attend at court, and hold the King's stirrup, when he mounts his horse, &c. There are four provosts of this kind, each of whom attends in his turn monthly.

PROW, in navigation, denotes the head or fore-part of a ship, particularly in a galley, being that which is opposite to the poop or stern. In the middle of the prow is the beak that cuts the water, on the top of which is commonly some figure or hieroglyphic. The prow is lower than the poop, and contains fewer decks.

PRUNELLA, in botany, *self-heal*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ, or Labiatæ. Essential character: filaments forked, with an anther on one of the forks; stigma bifid. There are three species.

Prunella, *sal*, in pharmacy, a preparation of purified saltpetre, called also crystal mineral, made in this manner: having melted any quantity of saltpetre, cast a little flowers of sulphur upon it, and when that is burnt throw on more; and continue to do so till the nitre flow as clear as rock-water. Then with a clean iron or brass ladle take it out, and, putting it into moulds till coagulated, preserve it for use.

PRUNING, in gardening and agriculture, is the lopping off the superfluous branches of trees, in order to make them bear better fruit, grow higher, or appear more regular. Pruning, though an operation of very general use, is nevertheless rightly understood by few; nor can it be learned by rote, or, indeed, wholly by books, but requires a strict observation of the different manners of growth of the several sorts of fruit-trees; the proper method of doing which cannot be known, without carefully observing how each kind is naturally disposed to produce its fruit; for some do this on the same year's wood, as vines; others, for the most part, upon the former year's wood, as peaches, nectarines, &c. and others, upon spurs which are produced upon wood of three, four, &c. to fifteen or twenty years old, as pears, plumbs, cher-

ries, &c. Therefore, in order to the right management of fruit-trees, provision should always be made to have a sufficient quantity of bearing wood in every part of the trees, and at the same time there should not be a superfluity of useless branches, which would exhaust the strength of the trees, and cause them to decay in a few years. The reasons for pruning of fruit-trees are, 1. To preserve them longer in a vigorous bearing-state; 2. To render them more beautiful; and, 3. To cause the fruit to be larger and better tasted.

PRUNUS, in botany, *bird cherry-tree*, a genus of the Icosandria Monogynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft, inferior; petals five; drupe with a nut, having the sutures prominent. There are thirty-three species.

PRUSSIAN *blue*. A rich pigment had been known for a considerable time under the name of Prussian blue. It is prepared by drying blood, and mixing three parts of the dried residuum with two parts of the potash of commerce, and calcining the mixture in a crucible by a red heat: it is then boiled in successive portions of water, which are afterwards mixed together, and concentrated by evaporation. A solution is prepared of one part of sulphate of iron, and two parts of alum, and to this the liquor obtained from the calcined blood and alkali is added, as long as any precipitate is formed. This precipitate is of a green colour, but by washing it with a little dilute muriatic acid, it becomes of a dark rich blue colour. This forms the Prussian blue of commerce. The property of forming the colour depends on a peculiar principle combined with the alkali; that in the formation of the Prussian blue, this is transferred to the iron, and that it may be again abstracted from it by boiling the blue in an alkaline solution; the properties of the alkali are thus changed, and it acquires the power of again forming the precipitate of Prussian blue from a solution of sulphate of iron. The reason the precipitate is thrown down green, is that the alkali is not entirely saturated with the colouring principle; the excess of alkali throws down, therefore, a portion of yellow oxide of iron from the sulphate, which mingling with the blue precipitate, renders it green, and the muriatic acid gives the deep blue colour, by dissolving, and of course removing this oxide. See PRUSSIC *acid*.

PRUSSIATES, in chemistry, salts formed with the prussic acid. These salts have not been attentively examined, on account of their want of permanency, unless they are united with some metallic oxide; but the prussiate of potash and iron, which is a triple salt, has been used by chemists as the best combination of prussic acid for detecting the existence of iron. In chemistry and mineralogy this is a very important substance, as it is capable of indicating whether most metallic substances be present in any solution whatever, and of pointing out the particular metal, and of ascertaining its quantity. This is done by precipitating the metals from their solution in consequence of the insoluble compound which it forms with them. The colour of the precipitate indicates the particular metal, while its quantity enables us to judge of the proportion of metallic oxide contained in any solution. This salt has obtained, at different times, the names of Prussian alkali, phlogisticated alkali, Prussian test, &c. This salt, though of great importance as a test, is of no use whatever, if it be not quite pure. There are two ways in which this test may be rendered impure, besides the introduction of foreign ingredients, which it is needless to mention, because it is obvious that it must be guarded against. 1. There may be a superabundance of alkali present, or, which is the same thing, there may be mixed with the Prussian test, a quantity of pure alkali; or, 2. There may be contained in it a quantity of yellow prussiate of iron, for which prussiate of potash has also a considerable affinity. If the Prussian test contain a superabundance of alkali, two inconveniences follow. This superabundant quantity will precipitate those earthy salts which are liable to contain an excess of acid, and which are only soluble by that excess. Hence alumina and barytes will be precipitated. Another inconvenience arising from the superabundance of alkali in the Prussian test is, that it gradually decomposes the blue prussiate which the test contains, and converts it into a yellow prussiate. In what manner it does this will be understood, after what has been said, without any explanation. On the other hand, when the Prussian alkali contains a quantity of yellow prussiate of iron, as great inconveniences follow. This yellow prussiate has an affinity for prussic acid, which, though inferior to that of the potash, is still considerable; and, on the other hand, the potash has a stronger affinity for every other acid than for the prus-

sic. When, therefore, the test is exposed to the air, the carbonic acid, which the atmosphere always contains, assisted by the affinity between the yellow prussiate and the prussic acid, decomposes the prussiate of potash in the test, and the yellow prussiate is precipitated in the form of Prussian blue, and every other acid produces the same effect. A test of this kind would indicate the presence of iron in every mixture which contains an acid (for a precipitation of Prussian blue would appear), and could not therefore be employed with any confidence.

PRUSSIC *acid*, in chemistry and the arts, is one of the most important of the acids. It was discovered by accident about the beginning of the last century by Diesbach, a chemist of Berlin. This gentleman, wishing to precipitate a decoction of cochineal with an alkali, got some potash on which he had distilled several times his animal oil, and as there was some sulphate of iron in the decoction, the liquor instantly exhibited a beautiful blue in the place of a red precipitate. Hence he saw the method of producing the same substance at pleasure, and it soon became an object of commerce, and obtained the name of Prussian blue, from the place where it was discovered. This substance is now formed, chiefly, during the decomposition of animal substances in high temperatures. Three parts of blood, evaporated to dryness in an iron dish, are to be mixed with one part of subcarbonate of potash (common pearlash), and calcined in a crucible, which should be only two-thirds filled by the materials, and covered with a lid. The calcination must be continued, with a moderate heat, as long as a blue flame issues from the crucible; and when it becomes faint, and likely to be extinguished, the process must be stopped. Throw the mass, when cold, into ten or twelve parts of water; allow it to soak a few hours, and then boil them together in an iron kettle. Filter the liquor, and continue pouring hot water on the mass as long as it acquires any taste. To this solution add one composed of two parts of alum and one of sulphate of iron, in eight or ten of boiling water, and continue the mixture as long as any effervescence and precipitation ensues. Wash the precipitate several times with boiling water. It will have a green colour; but, on the addition of a quantity of muriatic acid, equal to twice that of the sulphate of iron which has been used, it will assume a beautiful blue colour. Wash is again with water, and dry it in a gentle heat. In this state it is the pigment, called Prussian blue, which consists of a mixture of prussiate of iron with alumine. From prussiate of iron, the prussic acid may be separated by the following process: mix two ounces of red oxide of mercury, prepared by nitric acid, with four ounces of finely powdered Prussian blue, and boil the mixture with twelve ounces of water in a glass vessel, shaking frequently. Filter the solution, which is a prussiate of mercury, while hot, and when cool, add to it, in a bottle, two ounces of iron filings, and six or seven drachms of sulphuric acid; shake these together, decant the clear liquor into a retort, and distil off one-fourth of the liquor. The distilled liquor is the prussic acid, which combines with alkalies and earths, and has many of the properties belonging to the other acids. It has a sweetish taste, and a smell resembling that of bitter almonds; it does not redden blue vegetable colours. It precipitates sulphurets, and curdles soap. It separates alumine from nitric acid. Oxygenized muriatic acid entirely decomposes it. It does not appear to have a strong affinity for alkalies, nor does it take them from carbonic acid, for no effervescence arises on adding it to a solution of alkaline carbonates; on the contrary, its combinations with alkalies and earths are decomposed by exposure to carbonic acid, even when highly diluted, as in atmospheric air. It readily combines, however, with pure alkalies, destroys their alkaline properties, and forms crystallizable salts. It does not precipitate iron blue, but green, and this green precipitate is soluble in acids. The rays of light render the green precipitate blue, as does also the addition of metallic iron, or sulphurous-acid.

PSIDIUM, in botany, *guava*, a genus of the Icosandria Monogynia class and order. Natural order of Hesperidæ. Myrti, Jussieu. Essential character: calyx five-cleft superior; petals five; berry one-celled, many-seeded. There are eight species, natives of the East and West Indies.

PSITTACUS, the *parrot*, in natural history, a genus of birds of the order Picæ. Generic character: bill hooked, upper mandible moveable; nostrils round in the base of the bill, and sometimes covered with a cere; tongue fleshy, broad, and blunt at the end; head large, crown flat; toes formed

for climbing. These abound within the tropics, and live on seeds and fruits in their natural state, but in confinement will eat both flesh and fish. They often appear in flocks, yet are in such cases generally somewhat separated into pairs. They are noisy, mimetic, singularly capable of articulating human sounds, extremely docile and long lived. They breed in the hollows of trees, without constructing any nest, and use their feet as hands to convey food to their mouths. Latham notices one hundred and thirty-three species, and Gmelin no fewer than one hundred and sixty-nine. The general division is regulated by the evenness or unevenness of the tails. The following are the principal species.

P. macao, or the red and blue maccaw, is as large as a capon, and inhabits South America. With its bill it breaks a peach-stone with the most perfect ease. These birds lay their eggs in decayed trees, and often enlarge the hollow for this purpose with their bills. They are used for food in vast numbers in Cayenne. They are, in common with many species, exposed to fits when confined.

P. rufirostris, or the long-tailed green parrakeet, is of the size of a blackbird, extremely clamorous, and highly imitative. These birds are seen in large flocks, and alighting on certain trees, can with difficulty be distinguished, in consequence of the similar colour of their plumage to that of the leaves. They inhabit various parts of America, are used for food, and are extremely fat. The above have tails uneven at the end.

P. Meluccensis, or the Molucca cockatoo, inhabits the Moluccas, is about fifteen inches long, and is regarded by Buffon as one of the most docile and interesting birds of the tribe.

P. pullarius, or the red-headed Guinea parrakeet, is of the size of a lark, and is extremely common in many parts of Africa. These birds are peculiarly distinguished by their mutual affection. They are exported from Africa in considerable numbers for their beauty and attachment, and not on account of any power of articulation or enchantment of melody, their sounds being harsh and grating. Few, however, survive the voyage. They are kept in cages, in pairs, and the attentions of the male to the female are highly tender, elegant, and interesting. He extricates the seeds from their husks, and presents them to her in this prepared state, and appears restless and miserable on the slightest separation. Indeed the attachment is reciprocal, the sadness of one always producing distress in the other; and the death of either involving the survivor, generally, in fatal as well as fruitless grief.

PSOPHIA, the *trumpeter*, in natural history, a genus of birds of the order Grallæ. Generic character: bill cylindrical, conic, convex; nostrils oval, sunk, and pervious; tongue cartilaginous, flat, and fringed at the tip; feet four-toed and cleft. Latham mentions only one species, viz. P. crepitans, or the gold-breasted trumpeter, is of the size of a large fowl, and very high on its legs, and abounds in South America, especially in the country of the Amazons. It is remarkable for emitting from its lungs a noise very similar to the sound of a child's trumpet, and, being easily domesticated, will often follow the person to whose care it is committed through the streets, making this singular noise. It may be fed on bread and fish. It runs fast, aided by the expansion of its wings. When confined with poultry it often annoys both common fowls and turkeys, and, indeed, occasionally, destroys them. It will follow the Negroes in the West Indies, and catch at their legs, not unfrequently producing blood. Their flesh is esteemed a considerable delicacy.

PSORALEA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx besprinkled with callous dots, the same length with the legume, which has only one seed in it. There are thirty-three species, chiefly natives of the Cape of Good Hope.

PSYCHOTRIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx five-toothed, crowning; corolla tubular; berry globular; seeds two, hemispherical, grooved. There are thirty-nine species.

PTELEA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx four-parted, inferior; corolla four-petalled; stigmas two; fruit with a roundish membrane, having one seed in the middle. There is but one species, viz. P. trifoliata, three-leaved ptelea, or shrubby trefoil, a native of North America.

PTERIS, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Generic charac-

ter: fructifications in an uninterrupted marginal line; involucre from the margin of the frond turned in, uninterrupted, separating on the inner side. There are thirty-four species.

PTEROCARPUS, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five-toothed; capsule sickle-shaped, leafy, varicose; seeds few, solitary. There are six species, found chiefly in South America and the West Indies.

PTERONIA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoidæ. Cinarocephalæ, Jussieu. Essential character: receptacle with many-parted bristles; down subplumose; calyx imbricate. There are eighteen species, all found at the Cape of Good Hope.

PTEROSPERMUM, in botany, a genus of the Monadelphia Dodecandria class and order. Essential character: calyx single, five-parted; corolla five-petalled; filaments fifteen, with five ligules, one between every three filaments; capsule five-celled, with the cells two-valved; seeds many, winged. There are two species, *viz.* P. suberifolium and P. acerifolium, both natives of the East Indies.

PTEROTRACHEA, in natural history, a genus of the Vermes Mollusca class and order. Generic character: body detached, gelatinous, with a moveable fin at the abdomen or tail; two eyes placed within the head. There are four species.

PTINUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform, the last joints larger; thorax nearly round, not margined, receiving the head. There are about forty species, divided into sections: A. feelers clavate, lip entire. B. feelers filiform, lip bifid. Of the former section is P. pulsator, or death watch, which is of a dusky colour, with irregular grey brown spots. This insect is found in various parts of Europe in old wooden furniture, makes a peculiar ticking with the fore part of its head, resembling the beating with the nail upon a table: this is done in several distinct strokes in the night time, and has been considered by the common people as prophetic of some fatal occurrence in the family, but is nothing more than the call of one sex to the other. This must not be confounded with a much smaller insect of a very different genus, which makes a sound like the ticking of a watch, and continues for a long time without intermission. This belongs to a different order, and is the Termes pulsatorium of Linnæus. But the real death-watch of vulgar superstition is the ptinus. P. pertinax is brown, immaculate; thorax compressed. It inhabits Europe, and is very destructive to wooden furniture and books. When touched it draws in its head and legs, and becomes immoveable.

PTOLEMAIC, or PTOLEMÆAN *system of astronomy*, is that invented by Claudius Ptolemy. This hypothesis supposes the earth immoveably fixed in the centre, not of the world only, but also of the universe: and that the sun, the moon, the planets, and stars all move about it from east to west, once in twenty-four hours, in the order following, *viz.* the Moon next to the Earth, then Mercury, Venus, the Sun, Mars, Jupiter, Saturn, the fixed stars, the first and second crystalline heavens, and above all the fiction of their *primum mobile*. This system, or hypothesis, was first invented, and adhered to, chiefly because it seemed to correspond with the sensible appearances of the celestial motions.

PTOLEMY (CLAUDIUS), in biography, a very celebrated geographer, astronomer, and mathematician, among the ancients, was born at Pelusium, in Egypt, about the seventieth year of the Christian era, and died, it has been said, in the seventy-eighth year of his age, and in the year of Christ 147. He taught astronomy at Alexandria, in Egypt, where he made many astronomical observations, and composed his other works. It is certain that he flourished in the reigns of Marcus Antoninus and Adrian; for it is noted in his Canon, that Antoninus Pius reigned twenty-three years, which shows that he himself survived him: he also tells us in one place, that he made a great many observations upon the fixed stars at Alexandria, in the second year of Antoninus Pius; and in another, that he observed an eclipse of the moon in the ninth year of Adrian; from which it is reasonable to conclude, that this astronomer's observations upon the heavens were many of them made between the year 125 and 140.

Ptolemy has always been reckoned the prince of astronomers among the ancients, and in his works has left us an entire body of that science. He has preserved and transmitted to us the observations and principal discoveries of the ancients, and at the same time augmented and enriched them with his own. He corrected Hipparchus's

catalogue of the fixed stars; and formed tables, by which the motions of the sun, moon, and planets might be calculated and regulated. He was, indeed, the first who collected the scattered and detached observations of the ancients, and digested them into a system, which he set forth in his "Μεγαλη Συνταξις, sive Magna Constructio," divided into thirteen books. He adopts and exhibits here the ancient system of the world, which placed the earth in the centre of the universe; and this has been called, from him, the Ptolemaic System, to distinguish it from those of Copernicus and Tycho Brahe.

About the year 827, this work was translated by the Arabians into their language, in which it was called "Almagestum," by order of one of their kings; and from Arabic into Latin, about 1230, by the encouragement of the Emperor Frederic II. There were also other versions from the Arabic into Latin; and a manuscript of one done by Girardus Cremonensis, who flourished about the middle of the fourteenth century, Fabricius says, is still extant in the library of All Souls College, in Oxford. The Greek text of this work began to be read in Europe in the fifteenth century, and was first published by Simon Grynæus, at Basil, 1538, in folio, with the eleven books of Commentaries by Theon, who flourished at Alexandria in the reign of the elder Theodosius. In 1541, it was reprinted at Basil, with a Latin version by George Trapezond; and again at the same place in 1551, with the addition of other works of Ptolemy, and Latin versions by Camerarius. We learn from Kepler, that this last edition was used by Tycho.

Of this principal work of the ancient astronomers, it may not be improper to give here a more particular account. In general it may observed, that the work is founded upon the hypothesis of the earth's being at rest in the centre of the universe, and that the heavenly bodies, the stars and planets, all move round it in solid orbs, whose motions are all directed by one, which Ptolemy calls the *primum mobile*, or First Mover, of which he discourses at large. But, to be more particular, this great work is divided into thirteen books.

In the first book, Ptolemy shows that the earth is in the centre of those orbs, and of the universe itself, as he understood it; he represents the earth as of a spherical figure, and but as a point in comparison of the rest of the heavenly bodies: he treats concerning the several circles of the earth, and their distances from the equator; as also of the right and oblique ascension of the heavenly bodies in a right sphere.

In the second book he treats of the habitable parts of the earth; of the elevation of the pole in an oblique sphere, and the various angles which the several circles make with the horizon, according to the different latitude of places; also of the phenomena of the heavenly bodies depending on the same.

In the third book he treats of the quantity of the year, and of the unequal motion of the sun through the zodiac: he here gives the method of computing the mean motion of the sun, with tables of the same; and likewise treats of the inequality of days and nights.

In the fourth book he treats of the lunar motions, and their various phenomena; he gives tables for finding the moon's mean motions, with her latitude and longitude; he discourses largely concerning lunar epicycles; and by comparing the times of a great number of eclipses mentioned by Hipparchus, Calippus, and others, he has computed the places of the sun and moon, according to their mean motions, from the first year of Nabonazar, king of Egypt, to his own time.

In the fifth book he treats of the instrument called the astrolabe; he treats also of the eccentricity of the lunar orbit, and the inequality of the moon's motion according to her distance from the sun; he also gives tables, and an universal canon for the inequality of the lunar motions: he then treats of the different aspects or phases of the moon, and gives a computation of the diameter of the sun and moon, with the magnitude of the sun, moon, and earth compared together; he states also the different measures of the distance of the sun and moon, according as they are determined by ancient mathematicians and philosophers.

In the sixth book he treats of the conjunctions and oppositions of the sun and moon, with tables for computing the mean time when they happen; of the boundaries of solar and lunar eclipses; of the tables and methods of computing the eclipses of the sun and moon, with many other particulars.

In the seventh book he treats of the fixed stars, and shows the methods of describing them, in their various constellations, on the surface of an artificial sphere or globe; he rectifies the places of the stars to his own

time, and shows how different these places were then, from what they had been in the times of Timocharis, Hipparchus, Aristillus, Calippus, and others: he then lays down a catalogue of the stars in each of the northern constellations, with their latitude, longitude, and magnitudes.

In the eighth book he gives a like catalogue of the stars in the constellations of the southern hemisphere, and in the twelve signs or constellations of the zodiac. This is the first catalogue of the stars now extant, and forms the most valuable part of Ptolemy's works. He then treats of the galaxy, or milky-way; also of the planetary aspects, with the rising and setting of the sun, moon, and stars.

In the ninth book he treats of the order of the sun, moon, and planets, with the periodical revolutions of the five planets; then he gives tables of the mean motions, beginning with the theory of Mercury, and showing its various phenomena with respect to the earth.

The tenth book begins with the theory of the planet Venus, treating of its greatest distance from the sun; of its epicycle, eccentricity, and periodical motions; it then treats of the same particulars in the planet Mars.

The eleventh book treats of the same circumstances in the theory of the planets Jupiter and Saturn. It also corrects all the planetary motions, from observations made from the time of Nabonazar to his own.

The twelfth book treats of the retrogressive motion of the several planets, giving also tables of their stations, and of the greatest distances of Venus and Mercury from the sun.

The thirteenth book treats of the several hypotheses of the latitude of the five planets; of the greatest latitude or inclination of the orbits of the five planets, which are computed and disposed in tables; of the rising and setting of the planets, with tables of them. Then follows a conclusion or winding-up of the whole work.

This great work of Ptolemy will always be valuable on account of the observations he gives of the places of the stars and planets in former times, and according to ancient philosophers and astronomers, that were then extant; but principally on account of the large and curious catalogue of the stars, which being compared with their places at present, we thence deduce the true quantity of their slow progressive motion according to the order of the signs, or of the precession of the equinoxes.

Another great and important work of Ptolemy was, his Geography, in seven books; in which, with his usual sagacity, he searches out and marks the situation of places according to their latitudes and longitudes; and he was the first that did so. Though this work must needs fall far short of perfection, through the want of necessary observations, yet it is of considerable merit, and has been very useful to modern geographers. Cellarius, indeed, suspects, and he was a very competent judge, that Ptolemy did not use all the care and application which the nature of his work required; and his reason is, that the author delivers himself with the same fluency and appearance of certainty, concerning things and places at the remotest distance, which it was impossible he could know any thing of, that he does concerning those which lay the nearest to him, and fall the most under his cognizance. Salmasius had before made some remarks to the same purpose upon this work of Ptolemy. The Greek text of this work was first published by itself at Basil, in 1533, in quarto: afterwards with a Latin version, and notes, by Gerard Mercator, at Amsterdam, 1605; which last edition was reprinted at the same place, 1618, in folio, with neat geographical tables by Bertius.

Other works of Ptolemy, though less considerable than these two, are still extant. As, "Libri quatuor de Judiciis Astrorum," upon the first two books of which Cardan wrote a commentary; "Fructus Librorum suorum," a kind of supplement to the former work; "Recentio Chronologica Regum;" this, with another work of Ptolemy, "De Hypothesibus Planetarum," was published in 1620, 4to., by John Bainbridge, the Savilian Professor of Astronomy at Oxford, and Scaliger, Petavius, Dodwell, and the other chronological writers have made great use of it; "Apparentiæ Stellarum Inerrantium;" this was published at Paris by Petavius, with a Latin version, 1630, in folio; but from a mutilated copy, the defects of which have since been supplied from a perfect one, which Sir Henry Saville had communicated to Archbishop Usher, by Fabricius, in the third volume of his Bibliotheca Græca; "Elementarum Harmonicarum libri tres," published in Greek and Latin, with a Commentary, by Porphyry, the philosopher, by Dr. Wallis, at Oxford, 1682,

in 4to.; and afterwards reprinted there, and inserted in the third volume of Wallis's works, 1699, in folio.

Mabillon exhibits, in his German Travels, an effigy of Ptolemy looking at the stars through an optical tube; which effigy, he says, he found in a manuscript of the thirteenth century, made by Conradus, a monk. Hence, some have fancied, that the use of the telescope was known to Conradus. But this is only matter of mere conjecture, there being no facts or testimonies, nor even probabilities, to support such an opinion.

It is likely that the tube was nothing more than a plain open one, employed to strengthen and defend the eyesight, when looking at particular stars, by excluding adventitious rays from other stars and objects, a contrivance which no observer of the heavens can ever be supposed to have been without.

PUBES. See Anatomy.

Pubes, in botany, *hair* or *down;* a general term expressive of all the hairy and glandulous appearances on the surface of plants. They are supposed to serve the double purpose of defensive weapons, and vessels of secretion. Different species of hairs have obtained different names; some are visible to the naked eye, while others are rendered visible only by the help of glasses; they are of different forms, in leguminous plants they are usually cylindric; in the mallow tribe, terminated in a point; in agrimony, shaped like a fish hook; in the nettle, awl-shaped and jointed; and in some compound flowers, they end in two crooked points.

PUBLIC *worship.* By law all contemners of public worship shall be, *ipso facto,* excommunicated; and if any person shall disturb a preacher in his sermon by word or deed, he shall be apprehended and carried before a justice, who shall commit him to goal for three months.

PUDDING *stone,* in chemistry, a term invented by English lapidaries to designate one particular mineral aggregate, consisting of oblong and rounded pebbles of flint, about the size of almonds, imbedded in a hard siliceous cement. The pebbles are usually black, and the cement a light yellowish brown. It is capable of receiving a very high polish and is used in ornamental works. It is found chiefly in Essex. The French mineralogists have naturalized the term, *poudingue,* and have applied it to all rounded stones imbedded in a cement, so as to make it nearly synonimous to the English "rubble-stone."

PUGIL, in physic, &c. such a quantity of flowers, seeds, or the like, as may be taken up between the thumb and two fore-fingers.

PUISNE, younger, junior; as, a puisne judge.

PULEX, in natural history, the *flea,* a genus of insects of the order aptera. Generic character: mouth without jaws or feelers, with a long inflected proboscis, covered at the base with two ovate laminæ; the sheat two-valved, five-jointed, and concealing a single bristle; lip rounded and fringed with reflected prickles; antennæ projecting, moniliform; two eyes; abdomen compressed; six legs formed for leaping. There are two species, viz. P. irritans, the common flea: and P. penetrans, or chigger.

The common flea is remarkable for undergoing the several changes experienced by the greater part of the insect-race of other tribes, being produced from an egg in the form of a minute larva, which changes to a chrysalis, in order to give birth to the perfect animal. The egg is small, oval and white, and from this in a few days is hatched the larva, which is destitute of feet, beset with hairs, and furnished at the head with a pair of short antennæ, and at the tail with a pair of slightly curved forks. The larvæ in about ten days arrive at their full growth, when they cease to feed, and casting their skin, change into the state of a chrysalis, which is of a white colour, and of an oval shape, with a slightly pointed extremity, and exhibits the immature limbs of the included insect. After remaining in the chrysalis-state about a fortnight the complete insect emerges, in its perfect form. The singularity most worthy of notice in the flea is the situation of the first pair of legs, which are placed beneath the head. The eyes are large, round, and black: the male is smaller than the female, with the back rather sinking than convex, as it always is in the female.

P. penetrans, or chigger, is a native of South America and the West India islands: it is said to be exceedingly troublesome in the sugar colonies, penetrating into the skin of the inhabitants, where it lodges its eggs, and causes malignant, and sometimes fatal ulcers.

PULLEY, in mechanics, one of the mechanical powers, called by seamen a tackle. See Mechanics.

PULMONARIA, in botany, *lung-wort*, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Calyx prismatic, five-cornered; corolla, funnel-form, with an open throat. There are five species, of which P. officinalis, common lung-wort, has a perennial, fibrous root, lower leaves rough, about six inches long and two and a half broad, of a dark green on their upper side, marked with many broad whitish spots, pale underneath; stalks almost a foot in height, having several smaller leaves on them, standing alternately; the flowers are produced in small bunches at the top of the stalks; calyx tubulous, hairy, as long as the tube of the corolla; brims of the petal spread open, shaped like a cup, red, purple and blue in the same bunch. Woodville observes, that the name pulmonaria, seen to have arisen rather from the speckled appearance of the leaves, resembling that of the lungs, than from any intrinsic quality which experience has discovered to be useful in pulmonary complaints.

PULSE, in the animal œconomy, denotes the beating or throbbing of the heart and arteries.

PULTENÆA, in botany, so named in honour of William Pulteney, M. D. a genus of the Decandria Monogynia class and order. Generic character: calyx, five-toothed, with an appendage on each side; corolla, papilionaceous; the wings shorter than the standard; legume of one cell, with two seeds. There are six species, all natives of New Holland.

PULVERISATION, an operation, commonly employed in the apothecary's shop, by means of pestles and mortars. The bottom of the mortars should be concave; and their sides should neither be so inclined as not to allow the substances operated on to fall to the bottom between each stroke of the pestle, nor so perpendicular as to collect it too much together, and to retard the operation. The materials of which the pestles and mortars are formed, should resist both the mechanical and chemical action of the substances for which they are used. Wood, iron, marble, siliceous stones, porcelain, and glass, are all very properly employed; but copper, and metals containing copper, are to be avoided, especially where the article operated upon has a tendency to corrode the metal.

PUMICE, in mineralogy, is of a greyish white colour: it occurs in mass and disseminated, being always more or less carious. It is glistening with a silky lustre; its fracture is fibrous, its fragments are sharp edged; it is opaque, sometimes a little translucent on the edges; it is rather soft, but its particles in powder are very hard; it is fusible without addition before the blow-pipe into a white enamel; it is regarded as a volcanic product, and is wrought in considerable quarries in the Lipari islands, which are almost entirely composed of this mineral. It is found also in Sicily and Iceland. It is composed of

Silica	77.5
Alumina	17.5
Oxide of iron	1.75
	96.75
Loss	3.25
	100

This mineral is employed in the arts for grinding down metals, glass, ivory, &c. previously to polishing. It is likewise used in smoothing leather, and many other purposes of the like kind.

PUMP, in hydraulics, a machine formed on the model of a syringe, for raising of water. See Hydraulics.

Pump *air*. See Pneumatics.

Pump *chain*, consists of a long chain, equipped with a sufficient number of valves, at proper distances, which working upon two wheels, one above and the other below, passes downward through a wooden tube, and returns upward through another. It is managed by a long winch or roller, whereon several men may be employed at once, and thus it discharges, in a limited time, a much greater quantity of water than the common pump, and with less fatigue and inconvenience to the labourers. This machine was formerly exposed to several disagreeable accidents, by nature of its then construction. The chain was of too complicated a fabric, and the sprokel wheels, employed to wind it up from the ship's bottom, were deficient in a very material circumstance, *viz.* some contrivance to prevent the chain from sliding or jerking back upon the surface of the wheel, which frequently happened when the valves were charged with a considerable weight of water, or when the pump was violently worked. The links were evidently too short, and the unmechanical manner in which they were connected, exposed them to a great friction in passing round the wheels. Hence they were sometimes apt

to break or burst asunder in very dangerous situations, when it was extremely difficult, and sometimes impracticable to repair the chain. Of late, however, some considerable improvements have been made by Mr. Cole, under the direction of Captain Bentinck. The chain of this machine is more simple and mechanical, and less exposed to danger. It appears to have been first applied to the pump by Mr. Mylne, to exhaust the water from the caissons at Blackfriar's Bridge. It was thence transferred to the marine by Captain Bentick, after having received some material additions to answer that service. The principal superiority of this pump to the former is, 1. That the chain is more simple and easily worked, and consequently less exposed to injuries by friction. 2. That the chain is secured upon the wheel, and thereby prevented from jerking back when charged with a column of water. 3. That it may be easily taken up and repaired when broken or choked with ballast, &c. And, 4. That it discharges a much greater quantity of water, with an inferior number of men. This has been proved by experience, when two men (instead of four) discharged a tun of water in fifty-five seconds.

PUNCH, an instrument of iron or steel, used in several arts for the piercing or stamping holes in plates of metals, &c. being so contrived as not only to perforate, but to cut out and take away the piece. The punch is a principal instrument of the metal button-makers, wafer-makers, patch-makers, shoe-makers, &c.

PUNCHEON, a little block or piece of steel, on one end whereof is some figure, letter, or mark, engraven either in creux or relievo, impressions whereof are taken on metal, or some other matter, by striking it with a hammer on the end not engraved. There are various kinds of these puncheons used in the mechanical arts; such for instance are those of the goldsmiths, cutlers, pewterers, &c. The puncheon, in coining, is a piece of iron steeled, whereon the engraver has cut in relievo the several figures, arms, effigy, inscription, &c. that are to be in the matrices, wherewith the species are to be marked. Minters distinguish three kinds of puncheons, according to the three kinds of matrices to be made; that of the effigy, that of the cross, or arms, and that of the legend, or inscription. The first includes the whole portrait in relievo: the second are small, each only containing a piece of the cross or arms; for instance, a fleur-de-lys, an harp, a coronet, &c. by the assemblage of all which the intire matrice is formed. The puncheons of the legend only contain each one letter, and serve equally for the legend on the effigy side and the cross side.

Puncheon is also used for several iron-tools of various sizes and figures, used by the engravers in creux on metals. Seal-gravers particularly use a great number for the several pieces of arms, &c. to be engraven, and many stamp the whole seal from a single puncheon.

Puncheon is also a common name for all those iron instruments used by stone-cutters, sculptors, blacksmiths, &c. for the cutting, inciding, or piercing their several matters. Those of sculptors and statuaries serve for the repairing of statues when taken out of the moulds; the locksmiths use the greatest variety of puncheons; some for piercing hot, others for piercing cold; some flat, some square, some round, others oval, each to pierce holes of its respective figure in the several parts of locks.

Puncheon, in carpentry, is a piece of timber placed upright between two posts, whose bearing is too great, serving, together with them, to sustain some large weights. This term is also used for a piece of timber raised upright, under the ridge of a building, wherein the little forces, &c. are jointed.

Puncheon, is also used for the arbor, or principal part of a machine, whereon it turns vertically, as that of a crane, &c.

Puncheon is also a measure for liquids, containing an hogshead and one third, or eighty-four gallons.

PUNCTUATION, the art of dividing a written composition into sentences, or parts of sentences, by points or stops, for the purpose of marking the different pauses which the sense requires.

The comma (,) represents the shortest pause; the semicolon (;) a pause double that of the comma; the colon (:) double that of the semicolon; and the period (.) double that of the colon. The precise duration of these pauses must depend on the degree of slowness or rapidity observed in reading; but the proportion between them should be ever invariable.

In order to determine clearly the application of the points, it is necessary to distinguish between a simple sentence and a compound sentence. A simple sentence contains only one finite verb: as, "Virtue refines the affections." A compound sen-

tence has more than one finite verb expressed or implied, and therefore consists of two or more simple sentences connected together: as, "Virtue refines the affections; but vice debases them."

The comma is used to mark the pauses which occur in a simple sentence; the semicolon and the colon divide a compound sentence into the members which compose it; and the period is placed at the end of a sentence to denote that it is complete, and unconnected with that which follows.

In a simple sentence, when two or more words of the same sort, or belonging to the same part of speech, occur, they are parted by a comma: as, "Husband, wife, and children;" "open, generous, sincere;" "to read, mark, learn;" "to live soberly, righteously, and godly," &c.

Where the connection of the different parts of a simple sentence is interrupted by necessary adjuncts, either to the subject or to the verb, the separation is generally marked by a comma: as, "To rouse mankind, when sunk in ignorance or superstition, and to encounter the rage of bigotry, armed with power, required the utmost vehemence of zeal, and a temper daring to excess."

The semicolon is used for dividing a compound sentence, and hence it occurs most generally in cases where the comma has preceded, and a greater pause is necessary: as, "Tribulation worketh patience; and patience, experience; and experience, hope." "He knew how to conciliate the most enterprising spirit, with the coolest moderation; the most obstinate perseverance, with the easiest flexibility; the most severe justice, with the greatest lenity; the greatest rigour in command, with the greatest affability of deportment; the highest capacity and inclination for science, with the most shining talents for action." In each of these examples the first clause forms a complete sentence, and what is expressed in it is understood in those which follow.

The colon divides a compound sentence into parts less connected than those which are separated by a semicolon. It may be properly applied in the three following cases:

1. When a member of a sentence is complete in itself, but is followed by some supplemental remark, or further illustration of the subject: as, "The knowledge of nature is only half the task of a poet: he must be acquainted likewise with all the modes of life."

2. When several semicolons have preceded: as, "Those who propagate evil reports frequently invent them; and it is no breach of charity to suppose this to be always the case; because no man who spreads detraction would scruple to produce it: and he who should diffuse poisons in a brook would scarce be acquitted of a malicious design, though he should alledge that he received it of another who is doing the same elsewhere."

3. Where an example, a quotation, or a speech is introduced: as, "He was often heard to say: 'I have done with the world.'"

The period is employed to separate sentences which are not connected in construction; but it may be sometimes admitted, though they are joined by a copulative or disjunctive conjunction: as, "In passing judgment upon the characters of men, we ought to try them by the principles and maxims of their own age, and not by those of another. For, although virtue and vice are at all times the same, manners and customs vary continually."

Besides the points which mark the pauses in discourse, there are others, which denote a different modulation of voice in correspondence to the sense. These are,

The interrogation point.... ?
The exclamation point..... !
The parenthesis............. (

The interrogation and exclamation points are sufficiently explained by their names: they are indeterminate as to their duration, and may in that respect be equivalent to a semicolon, a colon, or a period, as the sense requires. They generally mark an elevation of the voice.

The parenthesis is a clause introduced into the body of a sentence without affecting the construction. It marks a moderate depression of the voice, and may be marked with every point which the sense would require if the parenthetical characters were omitted. It ought to terminate with the same kind of stop which the member has that precedes it; and to contain that stop within the parenthetical marks: as, "He found them asleep again; (for their eyes were heavy;) neither knew they what to answer him."

PUNICA, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Pumaceæ. Myrti, Jussieu. Essential character: calyx five-cleft, superior; petals five; pome many-celled, many-seeded. There are two species; viz. P. granatum, common pomegranate tree, and

P. nana, dwarf pomegranate tree; with several varieties, which are cultivated rather for the beauty of their scarlet-coloured flowers than for the fruit, which seldom arrives to any perfection in this country, so as to render it valuable.

PUR *auter vie*, where lands, &c. are held by another's life. See ESTATE.

PURCHASE, signifies the buying or acquisition of lands or tenements with money, or by deed or agreement; and not obtaining it by descent, or hereditary right.

PURITANS, a name given to the Protestant exiles who returned to England upon the accession of Queen Elizabeth. These exiles were no sooner come to their native country, than they set about to carry on the work of reformation, even further than it had been done by the ecclesiastical laws of Elizabeth. This princess, with those that had weathered the storm at home, were only for restoring King Edward's liturgy; but the majority of the exiles were for the worship and discipline of the foreign churches, and refused to conform to the usages of the old establishment, declaiming loudly against the popish habits and ceremonies. For a time the Queen connived at their non-conformity; but no sooner did she find herself firmly established on the throne, than she gave the Puritans, as the reforming exiles were reproachfully called, a specimen of her proud spirit, and the nation a proof of her secret attachment to the principles and many of the ceremonies of the Romish faith. A Puritan, at that time, was a man of severe morals, a Calvinist in doctrine, and a non-conformist to the ceremonies and discipline of the church. As they did not avowedly separate from the church, they seem to have acted, in this particular, somewhat like the Wesleyan Methodists of the present day.

The aversion which Queen Elizabeth conceived against the Puritans induced her to act against them in the most cruel and rigid manner. "For," says Neal, "besides the ordinary courts of the bishops, her Majesty erected a new tribunal, called the High Commission, which suspended and deprived men of their livings, not by the verdict of twelve men upon oath, but by the sovereign determination of three commissioners of her Majesty's own nomination, founded not upon the statute laws of the realm, but upon the bottomless deep of the canon law; and instead of producing witnesses in open court to prove the charge, they assumed a power of administering an oath *ex officio*, whereby the prisoner was obliged to answer all questions the court should put to him, though never so prejudicial to his own defence; if he refused to swear, he was imprisoned for contempt; and if he took the oath, he was convicted upon his own confession." Such are the ingenious intricacies which a spirit of intolerance can invent to puzzle and embarrass its victims!

Having already, in some degree, anticipated the history of the Puritans, in the article PRESBYTERIANS, it is almost unnecessary to enlarge in this place.

Mr. Hume, whom no one will accuse of an unwarrantable prejudice for the principles of civil and religious liberty, observes, when speaking of the conduct of Elizabeth, "so absolute was the authority of the crown, that the precious spark of liberty had been kindled, and was preserved by the Puritans alone, and it was to this sect, whose principles appear so frivolous, and habits so ridiculous, that the English owe the whole freedom of their constitution." When it is considered who it is that thus speaks of the Puritans, and when it is also considered what is meant by "the whole freedom of the English constitution," it will be thought that we, of the present day, are debtors, of no small magnitude, to the zeal and perseverance of the ancient Puritans.

It must, however, be granted, that when the persecutions, carried on against the Puritans, during the reign of Elizabeth and the Stuarts, had driven the Puritans once more to seek refuge abroad, they now, in their turn, persecuted others who dissented from them. Those who formed the colony of Massachusett's Bay, having never relinquished the principle of a national church establishment, were less tolerant than those who settled at Plymouth, at Rhode Island, and at Providence plantations. The consequence was, they did not fail to discover that their sufferings and trials had not fully taught them the lessons of christian forbearance and universal toleration. Happily for the peace and security of mankind, those lessons are now better understood; and little remains of the offensive parts of Puritanism, besides what is to be found in the genius of high Calvinism, still unhappily possessing the minds of some of the sectaries of our own time. We may, however, fairly hope, that the time is fast approaching, when the true principles of liberty shall be not only acknowledged, but fully acted upon; and the spirit of enthusiasm and bigotry known only to be execrated, and remembered

only to be avoided. See Dr. Toulmin's edition of Neal's history of the Puritans, and Palmer's Nonconformist's Memorial; two works of considerable merit, and fraught with information, on the history and principles of the Puritans. See also the articles, NON-CONFORMISTS, PRESBYTERIANS, PROTESTANTS, and REFORMATION.

PURLUE, or PURLIEU, signifies all that ground near any forest, which, being made forest by King Henry II. Richard I. and King John, was afterwards, by perambulations and grants of Henry III. severed again from the same, and made purlieu; that is to say, pure and free from the laws of the forest.

PURLUE *man*, or PURLIEU *man*, a person who has ground within the purlieu, and is qualified to hunt within the same, though under certain restrictions.

By a statute of Charles II. no man may keep greyhounds within the purlieu, or elsewhere within England and Wales, unless he have a free warrant, or be lord of a manor, or such a freehold as is seised in his own right, or in right of his wife, of lands, tenements, or hereditaments, of the clear yearly value of 40*l.* over and above all the charges of reprises of such estate of inheritance; or of lands, tenements, &c. in his own right, or in the right of his wife, for the term of life or lives, of the yearly value of 80*l.* over and above all charges and reprises; or that is worth, in goods or chattels, 400*l.* Others, that are not thus qualified, and yet have land in the purlieus, if they find beasts of the forest in their own ground, within the purlieu, may chase them out with little dogs, though not with greyhounds.

PURPLE. See DYEING.

PURPURE, POURPRE, or PURPLE, in heraldry, according to some, is one of the five colours of armories, compounded of gules and azure, bordering on violet, and, according to others, of a great deal of red and a little black. But it was excluded by the ancient heralds as only an imperfect colour. In the coats of noblemen, it is called amethyst; and, in those of princes, mercury. It is represented in engraving, by diagonal lines drawn from the sinister chief to the dexter base point.

PURSER, an officer aboard a man of war, who receives her victuals from the victualler, sees that it be well stowed, and keeps an account of what he every day delivered to the steward. He also keeps a list of the ship's company, and sets down exactly the day of each man's admission, in order to regulate the quantity of provisions to be delivered out, and that the pay-master or treasurer of the navy may issue out the disbursements, and pay off the men, according to his book.

PUS, in medicine. What is called healthy pus is about the consistence of cream, and of a yellowish-white colour, an insipid taste, and when it is cold, without smell. It produces no change on vegetable blues. When pus is exposed to a moderate heat, it dries, and assumes the appearance of horn. By distillation it gives out water in considerable proportion, ammonia and some gaseous substance, and an empyreumatic oil; a shining coaly matter remains behind, the ashes of which, after being burnt, afforded some traces of iron. The following tests have been given to distinguish pus from mucus, which is of considerable importance in cases where the formation of pus is suspected in the lungs. 1. Pus is soluble in sulphuric acid, and precipitated by water; mucus swims. 2. Pus may be diffused through water, diluted sulphuric acid, and brine; but mucus is not. 3. Pus is soluble in alkaline solutions, and is precipitated by water; but this is not the case with mucus. These are the properties of pus when it is secreted from a sore which is said to be in good condition, or in a disposition to heal. Its properties are very different in what are called ill-conditioned sores. In these cases, the matter secreted is thin, fetid, and acrid. Matter secreted by cancerous sores, which has been examined, converts the syrup of violets to a green colour; and from this matter sulphurated hydrogen gas is separated by means of sulphuric acid. This gas is supposed to exist in combination with ammonia.

PUTAMINEÆ, in botany, the name of the twenty-fifth order in Linnæus's Fragments of a Natural Method; the fleshy seed-vessel of which is frequently covered with a hard, woody shell: among the genera of this, are the capparis, caper-bush; and the crescentia, calabash-tree. Most of the plants of this order are acrid and penetrating, and yield, by burning, large quantities of alkali. The flower-buds of the caper-bush, preserved with vinegar, furnish the pickle well known by the name of capers. The calabash-tree is large and spreading, like an apple-tree: the fruit, when largest, is capable of holding, when the pulp is cleared out, about two gallons of water, and is used in the West Indies, as drinking cups, punch-bowls, and other articles of household furniture.

PUTREFACTION, is that spontaneous

process of decomposition which takes place in all the soft parts of animals, and some vegetables, by which they are finally disorganized, and resolved into a variety of gaseous and volatile substances which mix with the atmosphere. See PHYSIOLOGY.

PUTTING *in fear*. See ROBBERY.

PUTTOCKS, or PUTTOCK *shrouds*, in a ship, are small shrouds which go from the shrouds of the main-mast, fore-mast, and mizen mast, to the top-mast shrouds; and if there be any top-gallant masts, there are puttocks to go from the top-mast shrouds into these. These puttocks are at the bottom seized to a staff, or to some rope which is seized to a plate of iron, or to a dead man's eyes, to which the lanniards of the fore-mast shrouds do come.

PUTTY, in the arts, is a substance used in polishing metals, precious stones, and glass; it is also the base of most of the opaque enamels. It is made by calcining equal parts of tin and lead. Glazier's putty was probably composed of this true putty and oil; but what they now use is a mixture of whiting and linseed oil, which has the property of becoming very hard and durable by exposure to the air.

PUZZOLANA, or POZZULANA, a kind of earth found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples. It is thrown out from the burning mouths of volcanoes, in the form of ashes; sometimes in such large quantities, and with so great violence, that whole provinces have been covered with it at a considerable distance. Puzzolana is of a grey, brown, or blackish colour; of a loose, granular, or dusty and rough, porous or spongy texture, resembling a clay hardened by fire, and then reduced to a gross powder. It has various heterogeneous substances mixed with it. Its specific gravity is from 2.5 to 2.8; and it is, in some degree, magnetic: it scarcely effervesces with acids, though partially soluble in them. It easily melts *per se*; but its most distinguishing property is, that it hardens very suddenly when mixed with one-third of its weight of lime and water; and forms a cement which is more durable in water than any other. According to Bergman's analysis, 100 parts of it contain from 55 to 60 of siliceous earth, 20 of argillaceous, 5 or 6 of calcareous, and from 15 to 20 of iron. Its effects, however, in cement may perhaps depend only on the iron which has been reduced into a particular substance by means of subterraneous fires; evident signs of which are observable in the places where it is obtained.

PYRAMID, in architecture: this form we derive from the Egyptians, a people who conceived and executed unparalleled works, which are, however, more remarkable for their strength and durability than elegance of outline, and beauty of execution. According to Herodotus, the people alluded to considered the pyramidal form as emblematic of human life, the broad base representing the commencement, and the gradation, to a point, the termination of our existence in the present state; hence they used it for sepulchral purposes: it would be absurd to contradict this assertion, as the period of their erection is too remote for enquiry, with any probable success; but there is another obvious reason for the adoption of the shape, which of all others is most decidedly calculated to resist the operations of time. Admitting a monarch to have conceived an idea of rendering his tomb almost everlasting, it was impossible to invent an outline less liable to injury from the assaults of wind and rain, and the very disposition of the stones made it impossible that it should fall even through the operations of an earthquake, besides the immense extent of their bases, and the solidity of the workmanship made it highly improbable that his successors, or the people, would be at the trouble and expense of destroying it through disrespect to his memory; this circumstance, perhaps, united with the former consideration, were sufficient inducements for the selection of the pyramid for monuments.

Some authors derive the word from the Greek for wheat and its receptacle, and those assert that pyramids were originally built by the Patriarch Joseph as granaries; others derive it from the word πυρ, fire, thinking that the pyramidal shape resembles the ascent of flame.

There are several pyramids in Egypt, but those at Gizeh are the most gigantic; and the most enormous, or the great pyramid, is situated near Memphis. Herodotus says, he was informed the latter covered the remains of Cheops, and another adjoining those of his brother Cephrenes, who succeeded him; the first only having inner galleries, or passages. Although much dependence cannot be placed upon the further accounts of this ancient writer, it seems highly probable that an 100,000 men may have been constantly employed, for 20 years, in erecting the immense pile, and that Cheops became detested by the people, who were thus taken from more useful employments, as well as by the bulk of the

population, who found the taxes demanded of them appropriated to a purpose utterly unproductive of future advantage.

When M. Savary visited the pyramids of Gizeh the country was under the government of its present natives, whose kiaschif, or governor, for the above district, exacted a small tribute from travellers, and in return provided them with an escort, as a protection against the Arabs, who seized every opportunity to plunder them. The gentleman just mentioned, accompanied by some friends and the guards furnished by the kiaschif, departed from Gizeh at an hour after midnight, and were soon after gratified with a view of the two greatest pyramids, on the summits of which the moon shone with full splendour; as they approached them they assumed the appearance of vast pointed rocks penetrating the clouds. At half an hour past three in the morning the company prepared to enter the passages of the great pyramid by taking off great part of their clothing, and each taking a lighted torch in their hands, thus prepared they began a long descent, which at last became so much contracted that the party were compelled to crawl upon their hands and knees; this terminating, they commenced an ascent nearly under the same uncomfortable circumstances, except that they proceeded on their knees, and made use of their hands against the sides to facilitate their progress, and this mode of getting forward was necessary, as the stone at the bottom of the passage did not afford sufficient level for a firm step; when in this dismal gallery they were so imprudent as to discharge a pistol, the report of which long echoed and re-echoed through the place, and alarmed numbers of bats who darted against them and extinguished some of their torches. Succeeding in their efforts, they arrived at the upper termination of the second passage, where they passed through a very small door into a large oblong apartment, entirely composed of granite, seven enormous blocks of which formed the ceiling.

At one extremity of this apartment M. Savary saw an empty marble sarcophagus composed of one piece, but without a lid, and fragments of earthen vases lay scattered over the floor of the room; they also visited a second chamber, situated beneath that just described, and of smaller dimensions, which contained the entrance of a conduit then filled with rubbish. Satisfied with the progress they had made, the party descended by the passage already noticed, and with some difficulty avoided a deep and dangerous well on their left hands; on their arrival in the open air each person observed that his companions were pale and exhausted by the heat they endured when immured within the frightful abyss they had just explored.

After having rested their weary limbs, and recovered their strength and spirits, the party began to ascend the exterior of the pyramid, which consists, according to their enumeration, of above 200 gradations of stone, varying from two to four feet in height. This operation, fatiguing and severely laborious, occupied an hour; but on their reaching the summit they had the satisfaction of seeing that the rays of the approaching sun were darted on the points of Mokaltam, and not long after they beheld it rise from behind that mountain; the landscape, thus illuminated, they perceived, with infinite pleasure, the Nile and the adjoining fruitful fields, Gizeh, Grand Cairo, and part of the Delta, forming a striking contrast with the remainder of the view composed of sterile hills and wide spreading sands, with the intervening pyramids of Sakkara, three leagues from their then situation.

Fully sated with the rich prospect before them, they cut their names on the upper stones of the pyramid, and descended with the utmost caution, as this was a far more dangerous undertaking than the ascent; having reached the base in safety, they paced around it and contemplated the rugged mass with terror, which strongly resembles a vast pile of detached rocks when near it, but at a distance, the inequalities are lost, and the sides appear plain surfaces. The form of this immense monument prevents an accurate measurement of its dimensions, without severe labour and imminent danger; consequently, those authors who give them may have judged from mere conjecture. Herodotus mentions its reputed height, in his time, to have been 800 feet, and the width of each side of the base the same; Strabo made it 625 feet; but Diodorus reduces it to 600; modern observers have agreed with Strabo, and some of those bring it below Diodorus; if, however, an average may be permitted of these various accounts, that will amount to more than 500 feet.

One cause of the difference between the assumed heights is, that the pyramid is measured or observed on different sides; the north-east angle is most frequently

ascended, being the least damaged, but this part is exposed to the deserts of Libya, whence vast quantities of sand are driven by the wind against it, and the number of visible gradations are diminished by its accumulation; it is, therefore, evident that all admeasurements should be made at the opposite angle, where it is probable the rise in the earth has been less considerable, and yet to arrive at any degree of accuracy that should be ascertained by digging. Strabo mentions that the stone which closed the entrance to the apartments within the pyramid, was situated nearly half way up one of the sides, were this the fact, a very great rise in the neighbouring earth must have occurred, as it now appears to be not more than 100 feet from the base. Herodotus informs us, that the great and next pyramid, in size, were covered with white marble; and Diodorus and Pliny supposed they were wholly formed of that rich material; enough still remains on both to confirm the truth of the former assertion, which has escaped the labours of the Arabs, to whose indefatigable researches to discover supposed treasures within, we are indebted for the finding the entrance to the passage, and that the pyramid was intended as a sepulchral monument for the Egyptian princes.

Denon, who accompanied the ever-memorable expedition from France to Egypt, is the last visitor of the pyramids, and to him we are obliged for the following particulars of their present state.

General Buonaparte had determined to examine the great pyramids of Gizeh, and ordered an escort of near 300 men, Denon had the address to become one of the party, and they proceeded on the undertaking rather late in the day, owing to the difficulty of assembling the persons who composed it. Boats were procured to convey them, and they passed through the inundating trenches of the Nile to the boundary of the desert, within half a league of the pyramids. As they approached them Denon perceived that their sloping and angular forms had the effect of reducing their real height, which the eye was thus prevented from measuring with accuracy; besides as there are no other objects in their vicinity by which a comparison can be made, the mind is led to think of nature's grandest production, the mountain, and in consequence, the pyramid shrinks into insignificance. This impression was, however, very soon effaced, for as Denon advanced he saw an 100 persons assembled near the base, the deception instantly vanished, a comparison was formed, and the stupendous pile assumed all its appropriate majesty.

The party ascended a small heap of rubbish and sand, the probable remains of the trench of the first of these edifices which presents itself, and now conducting to the opening through which it may be reached; this aperture, said by Denon to be about 60 feet from the base, is hidden by a general facing of stone, forming the third or inner enclosure to the solitary entrenchment surrounding the pyramid. Large stones are laid horizontally on the sides of the entrance, and above those are others of enormous size, fitted at the ends so as to lean against each other, by this means rendering their fall or derangement impossible through the superincumbent weight. Hence commences the first gallery with a direction towards the centre and base of the monument; this gallery is now greatly clogged with the drifted sand of the desart, and the rubbish originally made by the efforts to explore the secrets of the edifice, it is consequently difficult of access. "At the extremity of this gallery," says Denon, "two large blocks of granite are met with, which form a second partition to this mysterious passage." The interruption made by those in the progress of past research was such, that various fruitless attempts have been made to surmount the impediment, and some have even had the folly to cut into the solid mass composing the pyramid, "but this proving unsuccessful they have returned some way, have passed round two blocks of stone, climbed over them, and thus discovered a second gallery of so steep an ascent that it has been necessary to hew steps in the ground in order to mount it. This gallery leads to a kind of landing-place in which is a hole usually called the well, which is the opening to an horizontal gallery leading to a chamber known by the name of the queen's chamber, without ornament, cornice, or any inscription whatever.

"Returning to the landing-place, an aperture, in a perpendicular direction, leads to the principal gallery, and this terminates in a second landing-place where a third and last partition is situated; as this is constructed with a greater degree of architectural care and propriety than the rest of the building, it may be inferred that the Egyptians considered it proper to guard the immediate deposit of their dead with peculiar attention.

"Lastly comes the royal chamber, con-

taining the sarcophagus, a narrow sanctuary, which is the sole end and object of an edifice so stupendous, so collossal."

We have thus enabled the reader to compare the two latest accounts of the pyramids of Egypt, and it will be found that though they differ in the method of description, that each author has been correct in stating the facts relating to them. Denon concludes his detail with several just and severe observations on the pride of those by whose order they were erected, and the barbarous ignorance and stupidity which governed those who obeyed its dictates; and yet, strange as it may appear, it becomes necessary to mention a pyramid erected by the very Frenchmen who having visited Egypt, and witnessed the effects of ancient despotism, perversely imitated the devotion of its inhabitants to a military idol, who has woefully convinced the world how little that devotion is deserved.

The pyramid alluded to is situated in Holland, was designed by the chief of the battalion of engineers of the French army there, is 110 French feet high, exclusive of an obelisk on the summit which is 42 feet more; and the sides have four inscriptions, three adulatory, and the last to the following purport: "This pyramid was raised to the august Emperor of the French, Napoleon the First, by the troops encamped in the plain of Zeyst, being a part of the French and Batavian army, commanded by the Commander in Chief, Marmont." As 30,000 men assisted in this undertaking it was completed in 32 days, in the year 12, by their computation.

PYRAMID, in geometry, a solid, standing on a triangular, square, or polygonal bases, and terminating in a point at the top; or according to Euclid, it is a solid figure, consisting of several triangles, whose bases are all in the same plane, and have one common vertex.

Hence the superficies of a given pyramid is easily found by measuring these triangles separately; for their sum added to the area of the base, is the surface of the pyramid required. It is no less easy to find the solid content of a given pyramid; for the area of the base being found, let it be multiplied by the third part of the height of the pyramid, or the third part of the base by the height, and the product will give the solid content, as is demonstrated by Euclid, lib. 12. prop. 7. If the solid content of a frustrum of a pyramid is required, first let the solid content of the whole pyramid be found; from which subtract the solid content of the part that is wanting, and the solid content of the frustrum, or broken pyramid, will remain. Every pyramid is equal to one third of its circumscribing prism, or that has the same base and height; that is, the solid content of the prism is equal to one-third of the prism. For supposing the base a square, then does the pyramid consist of an infinite number of such squares, whose sides, or roots, are continually increasing in arithmetical progression, beginning at the vertex or point, its base being the greatest term, and its perpendicular height the number of all the terms: but the last term multiplied into the number of terms will be triple the sum of all the series, equal the solid content of the pyramid.

All pyramids are in a ratio compounded of their bases and altitudes; so that if their bases be equal, they are in proportion to their altitudes; and *vice versa*. Equal pyramids reciprocate their bases and altitudes; that is, the altitude of one is to that of the other, as the base of the one is to that of the other.

PYRITES. Iron, in combination with sulphur, forms a mineral substance, which has been long known under the name of Pyrites, and which is very extensively diffused. It occurs massive, disseminated, and frequently crystallized: the forms of its crystals are various, but the most common is the cube regular, or modified by truncation of the angles or edges, or accumination of three planes on the angles: the octaedron, dodecaedron, and icosaedron, also sometimes occur.

Its colour is brass-yellow, varying a little in the shade, and the lustre is always fully metallic: it is opaque. The fracture is uneven. It is brittle; its hardness is such as to strike fire with steel; its specific gravity is from 4.6 to 4.8. By friction it exhales a sulphureous smell. This odour is strong when it is heated before the blowpipe; it gives at the same time a blue flame; and at length a globule of a brownish colour. It is soluble in nitric acid, with the disengagement of red vapours. It is not sensibly magnetic. Various analyses of it have been given: according to those executed by Mr. Hatchet, it consists of

Sulphur	52
Iron	48
	100

Besides this, which may be named common Pyrites, there are some others which may be regarded as varieties of the species,

and which differ principally in structure, or in the form under which they occur. The striated or radiated pyrites presents a striated fracture, the striæ being generally diverging.

It is rather more liable to tarnish than the preceding, and decomposes more readily in a humid atmosphere. According to Mr. Hatchet's analysis, it consists of

Sulphur	54
Iron	46
	100

The capillary pyrites occurs in delicate capillary crystals, grouped, parallel, diverging, or interwoven, slightly flexible, having a metallic lustre, and a colour passing from yellow to steel-grey. There is, lastly, the hepatic pyrites, so named from the liver-brown colour, which it assumes from exposure to the air. In the fresh fracture its colour is pale brass-yellow, inclining to steel-grey. It occurs massive, of various imitative forms, and crystallized in six-sided prisms, or six-sided pyramids: it has less lustre than the others, and is more subject to decomposition. What has been named magnetic pyrites, distinguished, as the name implies, by its magnetic quality, of which the others are destitute, has been considered as forming a distinct species. Its colour is deeper, being intermediate between brass-yellow and copper-red, and approaching even to brown, often tarnished: its lustre is also inferior, but is still metallic. It occurs only massive or disseminated. Its fracture is compact: it is hard and brittle: its specific gravity is 4.5. It appears from Mr. Hatchet's analysis of it to differ from the other iron pyrites, in containing a larger proportion of metal, to which, no doubt, its quality of being attracted by the magnet is owing.

PYROLA, in botany, *winter-green*, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx five-parted; petals five; capsule superior, five-celled, opening at the corners, many-seeded; anthers with two pores. There are six species, natives of the North of Europe.

PYROLIGNOUS and PYROTARTAROUS *acids*. When wood is distilled in close vessels, it always yields more or less of an acid juice: the same remark applies to the salt called tartar. These liquids were distinguished by the name of pyrolignous and pyrotartarous acids: but they are now known to be only the acetic disguised by the presence of a peculiar oil.

PYROMETER, an instrument for measuring the expansion of bodies by heat. The whole art in forming an instrument, adapted to this purpose, is so as to render it capable of showing very small expansions of solid bodies. Different instruments have been invented for this purpose; of the greater number of which it is scarcely necessary to give a detailed account. The difficulty of contriving an unexceptionable instrument of this kind has arisen partly from the difficulty of finding a substance not liable to be altered by a high temperature, and which shall suffer a change of volume sufficiently perceptible to be accurately measured; and partly from that of finding a measure, which shall not itself be affected by the high temperature, and be, at the same time, sufficiently delicate.

The pyrometer in which, perhaps, these difficulties have been most effectually surmounted, and which has come into most general use, is that invented by the late Mr. Wedgwood. The pure earth, named alumina, and the different earths, (the clays) in which it predominates, have the singular property of not expanding, but of contracting by heat. This contraction begins to become evident, when the clay is raised to a red heat, it continues to proceed until it vitrifies, and the total contraction, in pure clays, exceeds considerably one-fourth part of the volume in every direction. It occurred to Mr. Wedgwood, that from this property, it might be employed in the construction of a pyrometer. The contraction that the clay suffers is permanent, or it does not return to its former dimensions, when cold. The degree of contraction it has suffered, therefore, can be ascertained without any source of fallacy, and will indicate the extreme of temperature to which it has been exposed.

This pyrometer consists of a guage, composed of two straight pieces of brass, twenty-four inches long, divided into inches and tenths, and fixed in a brass plate, so as to converge; the space between them, at the one extremity, being five-tenths of an inch, and at the other three-tenths. The pyrometrical pieces of clay are small cylinders, flattened on one side, made in a mould, so as to be adapted exactly to the wider end. It is evident, that in exposing one of these pieces to a high temperature, the contraction it has suffered may be measured, by

the length to which it can be slid into the converging groove or gage.

The utility of this instrument, it was obvious, would be much increased by connecting it with the mercurial thermometer, and by ascertaining the proportion between the degrees of each; and this was done by Mr. Wedgwood. The scale of his pyrometer commences at red-heat fully visible in day-light. The mercurial thermometer cannot easily measure any temperature above 500° or 550°; and hence, between the termination of the scale in the one, and its commencement in the other, there is a range of temperature requiring to be measured. This Mr. Wedgwood did, by the expansions of a square piece of silver, measured in a gage of earthen-ware, constructed in the same way as his pyrometer; and by the same method, he found out the proportion between each degree of his scale, and that of any of the usual thermometrical scales. Each degree of his pyrometer he found to be equal to 130° of Fahrenheit. The commencement of his scale, or the point marked 0, corresponds with 1077½° of Fahrenheit's scale. From these data, it is easy to reduce either to the other, through their whole range. The scale of Wedgwood includes an extent of temperature equal to about 32,000° of Fahrenheit, or 54 times as much as that between the freezing and boiling points of mercury. Its commencement, as has been stated, is at 1077½° of Fahrenheit, or red heat fully visible in day-light; its extremity is 240°; but the highest heat that he measured with it is 160°, or 21,877° of Fahrenheit; being the temperature of a small air-furnace, and 30° of his scale above the point at which cast-iron melts.

Guyton has proposed a pyrometer for measuring high temperatures, in which platina, a metal not fusible even at very intense heats, is employed as the measure of expansion. A rod or plate of this metal is placed horizontally in a groove framed in a mass of hardened white clay; one extremity of the rod is supported on the mass which terminates the groove; the other presses against a bended lever of platina, the longest arm of which forms an index to a graduated arc. The expansion, which the rod of metal suffers from exposure to heat, is indicated by the change of position in this index. The mass of clay, being highly baked, will not introduce any important error from its contraction; and the expansion, which it may suffer during the exposure to heat, will affect only the small distance between the axis of motion of the index, and the point of contact of the plate, so as rather to diminish the effect than to increase it. Platina, having the important advantage of not melting by any heat we have to measure, and of not suffering any chemical change from it, is well adapted to the construction of a pyrometer.

Besides these, various metallic pyrometers have been invented capable of measuring low temperatures, by the expansion being multiplied by the aid of wheels, levers, or other mechanical contrivances, or being magnified by microscopes. Such are the pyrometers of Muschenbroeck; that described by Ferguson; one invented by Mr. Ellicot, with which he measured the expansions of various metals; one by Mr. Smeaton, and applied to the same purpose; Mr. Ramsden's, superior to the preceding ones in delicacy and accuracy; Mr. Crichton's, in which advantage is taken of the difference of expansion between a rod of zinc and a rod of iron, to give a curvature to the bar composed of the united rods, proportioned to the temperature to which they are raised; by which bending motion is given to an index that, at its other extremity, where the scale is marked, describes a considerable space; and, lastly, one by Regnier, on a principle somewhat similar, of which a report is presented to the French National Institute. The strict accuracy of these instruments may, from the nature of their construction, be regarded as doubtful. It has been found, by Ellicot's pyrometer, that the expansion of bars of different metals, by the same degree of heat, is as follows:

Gold.	Silver.	Brass.	Copper.	Iron.	Steel.	Lead.
73	103	95	89	60	56	149

PYROMUCUS *acid*. When sugar and other sweet-tasted substances are distilled, among other products there is always a notable quantity of an acid liquid. This acid, when rectified, obtained the names of syrupous acid, and afterwards pyromucous acid. It is now known from the recent experiments of Fourcroy and Vauquelin, that this acid is nothing else than the acetic, holding in solution a portion of empyreumatic oil.

PYROPE, in mineralogy, a species of the

Flint genus. Its colour is dark blood red, which, when held between the eye and the light, falls strongly into yellow. It occurs in angular grains, which are imbedded, but never crystallized; it is completely transparent and hard; specific gravity about 3.8. It is composed of

Silica	40.00
Alumina	28.50
Magnesia	10.00
Lime	3.50
Oxide of iron	16.50
——— manganese	0.25
	98.75
Loss	1.25
	100

It is found in many parts of Germany; also in Fifeshire in Scotland, in the sand of the sea-shore. It is employed in almost every kind of jewelry, and generally set in gold foil. The very small grains are powdered, and used in the stead of emery in cutting softer stones. This was formerly considered as a variety of the garnet, and denominated the Bohemian garnet, from its occurring in that country in great beauty and perfection. Werner has given the title to a distinct species, on account of its colour, transparency, and want of crystallization.

PYROPHORUS, in chemistry, a compound substance, which takes fire on the admission of the atmospheric air. It is prepared by exposing to heat in an iron pot, three parts of alum, with one part of flour; the mixture liquifies, and is to be stirred constantly till the whole becomes grey, and easily reducible to powder while hot.

The coarse powder is put into a coated phial, so as nearly to fill it; the mouth of the phial is stopped with a small plug of clay, and is placed in a crucible, and surrounded with sand up to the neck. The crucible is heated to redness, until a blue flame appears at the mouth of the phial; when this has continued ten minutes, the crucible is removed from the fire, and the phial, when sufficiently cold, is accurately stopped. This substance inflames in atmospheric air; in a moist atmosphere, the inflammation is much more speedy, and, in a dry air, it can scarcely take place. It burns also very brilliantly in oxygen gas, in nitrous gas, and in oxymuriatic acid gas; and is inflamed by the sulphuric and nitric acids. See ALUM.

PYROSTRIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Generic character: calyx very small, four-toothed; corolla bell-shaped, five-cleft, tomentose in the throat; stamina four; pistils one; stigma capitate; pericarpium drupe, pear-shaped, inferior, small, eight-streaked; nuts eight, one-seeded. There is but one species, *viz.* P. salicifolia, a native of the island of Mauritius.

PYROTECHNY, is, properly speaking, the science which teaches the management and application of fire in divers operations; but in a more limited sense, and as it is commonly used, it refers chiefly to the composition, structure, and use of artificial fire-works. The ingredients are, 1. saltpetre, purified for the purpose: 2. sulphur, and 3. charcoal. Gunpowder is likewise used in the composition of fire-works, being first ground, or as it is technically termed, mealed. Camphor and gum-benzoin are employed as ingredients in odoriferous fire-works. The proportions of the materials differ very much in different fire-works, and the utmost care and precaution are necessary in the working them to a state fit for use, and then in the mixing. In this work we cannot enter on the subject with a sufficient degree of minuteness to teach the method of making of fire-works, and shall therefore content ourselves with a brief notice of the proportions of the materials in some of the more common, and more interesting articles in use.

The charges for sky-rockets are made of saltpetre, four pounds; brimstone, one pound; and charcoal one pound and a half; or by another direction, saltpetre, four pounds; brimstone, one pound and a half; charcoal, twelve ounces; and meal-powder, two ounces. These proportions vary again according to the size of the rocket; in rockets of four ounces, mealed-powder, saltpetre, and charcoal, are used in the proportions of 10 : 2 and 1; but in very large rockets the proportions are saltpetre, four; mealed-powder and sulphur one each. When stars are wanted, camphor, alcohol, antimony, and other ingredients are required according as the stars are to be blue, white, &c. In some cases gold and silver rain is required; then brass-dust, steel-dust, saw-dust, &c. enter into the composition; hence the varieties may be almost indefinite. With respect to colour, sulphur gives a blue, camphor a white or pale colour, saltpetre a clear white yellow, sal-ammoniac a green, antimony a reddish, rosin a copper

colour. These materials require preparation before they are fit for use; and before a person can be qualified for the business of fire-work making, he must understand the method of making the moulds, cases, &c. and be acquainted with the instruments used in the art, their dimensions and materials. To discuss the several topics connected with the business, would require a space very much larger than could be afforded in this work, we shall therefore content ourselves with this notice, referring our readers to distinct treatises on the subject, which are to be found in the English and French language.

PYRUS, in botany, a genus of the Icosandria Pentagynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; pome inferior, five-celled, many-seeded. There are thirteen species, with many varieties. The P. communis, common pear-tree, grows to a lofty height, with upright branches, the twigs or branchlets hanging down; leaves elliptical, obtuse, serrate; the younger ones clothed with a deciduous cotton underneath and along the edge; stipules linear; flowers in terminating villose corymbs; corolla snow-white; pome produced at the base; hard and acerb, in the wild state, with five cells in the middle, each two-valved, containing two seeds. The wood of the pear is light, smooth, and compact; it is used by turners, also for joiners' tools, for picture frames, to be stained black; the leaves afford a yellow dye, and may be used to give a green to blued cloths: the juice of the fruit fermented is called Perry. The P. malus, common apple-tree, is very spreading, with the branches and twigs irregular and twisting, more horizontal than in the pear; leaves ovate, serrate, the younger ones pubescent underneath; stipules linear; flowers in terminating sessile, villose, umbels; corollas white inside, and finely tinged with red on the outside; fruit roundish, umbilicate at the base, acid. The wood of the wild apple is tolerably hard; it turns very clean, and when made into cogs for wheels, acquires a polish, and lasts a long time; the bark affords a yellow dye; the acid juice of the fruit is called verjuice; it is much used in recent sprains, and in other cases, as an astringent or repellent. For a full description of the numerous varieties of pears and apples, the reader is referred to Martyn's edition of Millar's "Gardener's and Botanist's Dictionary."

PYTHAGORAS, in biography, one of the greatest philosophers of antiquity, was born about the forty-seventh Olympiad, or 590 years before Christ. His father's principal residence was at Samos; but being a travelling merchant, his son Pythagoras was born at Sidon, in Syria; but soon returning home, our philosopher was brought up at Samos, where he was educated in a manner that was answerable to the great hopes that were conceived of him. He was called "the youth with a fine head of hair;" and from the great qualities that soon appeared in him, he was regarded as a good genius sent into the world for the benefit of mankind.

Samos, however, afforded no philosophers capable of satisfying his thirst for knowledge; and therefore, at eighteen years of age, he resolved to travel in quest of them elsewhere. The fame of Pherecydes drew him first to the island of Syros; from hence he went to Miletus, where he conversed with Thales. He then travelled to Phœnicia, and stayed some time at Sidon, the place of his birth; and from hence he passed into Egypt, where Thales and Solon had been before him.

Having spent twenty-five years in Egypt, to acquire all the learning and knowledge he could procure in that country, with the same view he travelled through Chaldea, and visited Babylon. Returning after some time, he went to Crete; and from hence to Sparta, to be instructed in the laws of Minos and Lycurgus. He then returned to Samos; which, finding under the tyranny of Polycrates, he quitted again, and visited the several countries of Greece. Passing through Peloponnesus, he stopped at Pholius, where Leo then reigned; and in his conversation with that prince, he spoke with so much eloquence and wisdom, that Leo was at once ravished and surprised.

From Peloponnesus he went into Italy, and passed some time at Heraclea and at Tarentum; but made his chief residence at Croton; where, after reforming the manners of the citizens by preaching, and establishing the city by wise and prudent counsels, he opened a school, to display the treasures of wisdom and learning he possessed. It is not to be wondered that he was soon attended by a crowd of disciples, who repaired to him from different parts of Greece and Italy.

He gave his scholars the rules of the Egyptian priests, and made them pass

through the austerities which he himself had endured. He at first enjoined them a five years' silence in the school, during which they were only to hear; after which leave was given them to start questions, and to propose doubts, under the caution, however, to say, "not a little in many words, but much in a few." Having gone through their probation, they were obliged, before they were admitted, to bring all their fortune into the common stock, which was managed by persons chosen on purpose, and called œconomists, and the whole community had all things in common.

The necessity of concealing their mysteries induced the Egyptians to make use of three sorts of styles, or ways of expressing their thoughts; the simple, the hieroglyphical, and the symbolical. In the simple, they spoke plainly and intelligibly, as in common conversation; in the hieroglyphical, they concealed their thoughts under certain images and characters; and in the symbolical, they explained them by short expressions, which, under a sense plain and simple, included another wholly figurative. Pythagoras borrowed these three different ways from the Egyptians in all the instructions he gave; but chiefly imitated the symbolical style; which he thought very proper to inculcate the greatest and most important truths; for a symbol, by its double sense, the proper and the figurative, teaches two things at once; and nothing pleases the mind more than the double image it represents to our view. In this manner Pythagoras delivered many excellent things concerning God, and the human soul, and a great variety of precepts, relating to the conduct of life, political as well as civil; he made also some considerable discoveries and advances in the arts and sciences. Thus, among the works ascribed to him, there are not only books of physic and books of morality, like that contained in what are called his "Golden Verses," but treatises on politics and theology. All these works are lost; but the vastness of his mind appears from the wonderful things he performed. He delivered, as antiquity relates, several cities of Italy and Sicily from the yoke of slavery; he appeased seditions in others; and he softened the manners, and brought to temper the most savage and unruly spirits of several people and tyrants. Phalaris, the tyrant of Sicily, it is said, was the only one who could withstand the remonstrances of Pythagoras; and he it seems was so enraged at his discourses, that he ordered him to be put to death. But though the lectures of the philosopher could make no impression on the tyrant, yet they were sufficient to reanimate the Sicilians, and to put them upon a bold action. In short, Phalaris was killed the same day that he had fixed for the death of the philosopher.

Pythagoras had a great veneration for marriage; and therefore himself married at Croton a daughter of one of the chief men of that city, by whom he had two sons and a daughter. One of the sons succeeded his father in the school, and became the master of Empedocles. The daughter, named Damo, was distinguished both by her learning and her virtues, and wrote an excellent commentary upon Homer. It is related, that Pythagoras had given her some of his writings, with express commands not to impart them to any but those of his own family; to which Damo was so scrupulously obedient, that even when she was reduced to extreme poverty, she refused a great sum of money for them.

From the country in which Pythagoras thus settled and gave his instructions, his society of disciples was called the Italic sect of philosophers, and their reputation continued for some ages afterwards, when the Academy and the Lycæum united to obscure and swallow up the Italic sect.

Pythagoras's disciples regarded the words of their master as the oracles of a god; his authority alone, though unsupported by reason, passed with them for reason itself; they looked upon him as the most perfect image of God among men. His house was called the temple of Ceres, and his court yard the temple of the Muses: and when he went into towns, it was said he went thither, "not to teach men, but to heal them."

Pythagoras was persecuted by bad men in the last years of his life, and some say he was killed in a tumult raised by them against him; but according to others, he died a natural death at 90 years of age, about 497 years before Christ.

Beside the high respect and veneration the world has always had for Pythagoras, on account of the excellence of his wisdom, his morality, his theology, and politics, he was renowned as learned in all the sciences, and a considerable inventor of many things in them; as arithmetic, geometry, astronomy, music, &c. In arithmetic, the common multiplication table is, to this day, still called Pythagoras's table. In geometry, it is

said he invented many theorems, particularly these three:—1. Only three polygons, or regular plane figures, can fill up the space about a point; *viz.* the equilateral triangle, the square, and the hexagon. 2. The sum of the three angles of every triangle is equal to two right angles. 3. In any right-angled triangle the square on the longest side is equal to both the squares on the two shorter sides. For the discovery of this last theorem, some authors say, he offered to the gods a hecatomb, or a sacrifice of a hundred oxen. Plutarch, however, says it was only one ox; and even that is questioned by Cicero, as inconsistent with his doctrine, which forbade bloody sacrifices. The more accurate therefore say, he sacrificed an ox made of flour, or of clay, and Plutarch even doubts whether such sacrifice, whatever it was, was made for the said theorem, or for that concerning the parabola, which it was said Pythagoras also found out.

In astronomy his inventions were many and great. It is reported that he discovered or maintained the true system of the world, which places the sun in the centre, and makes all the planets revolve about him: from him it is to this day called the old, or Pythagorean system; and is the same as that lately revived by Copernicus. He first discovered that Lucifer and Hesperus were but one and the same, being the planet Venus, though formerly thought to be two different stars. The invention of the obliquity of the zodiac is likewise ascribed to him. He first gave to the world the name Kosmos, from the order and beauty of all things comprehended in it; asserting that it was made according to musical proportion: for as he held that the sun, by him and his followers termed the fiery globe of unity, was seated in the midst of the universe, and the earth and planets moving around him, so he held that the seven planets had an harmonious motion, and their distances from the sun corresponded to the musical intervals or divisions of the monochord.

Pythagoras and his followers held the transmigration of souls, making them successively occupy one body after another; on which account they abstained from flesh, and lived chiefly on vegetables.

PYTHAGOREANS, a sect of ancient philosophers, so denominated from their being the followers of Pythagoras of Samos. See PYTHAGORAS.

Q.

Q, Or q, the sixteenth letter, and twelfth consonant, of our alphabet, but is not to be found either in the Greek, old Latin, or Saxon alphabets; and, indeed, some would entirely exclude it, pretending that k ought to be used wherever this occurs. However, as it is formed in the voice in a different manner, it is undoubtedly a distinct letter; for in expressing this sound the cheeks are contracted, and the lips, particularly the under one, are put into a cannular form, for the passage of the breath.

The q is never sounded alone, but in conjunction with u, as in *quality*, *question*, *quite*, *quote*, &c. and never ends any English word.

As a numeral, Q stands for 500; and with a dash over it, thus, $\bar{Q}$, for 500,000.

Used as an abbreviature, q. signifies quantity, or quantum: thus, among physicians, q. pl. is quantum placet, *i. e.* as much as you please of a thing; and q. s. quantum sufficit, *i. e.* as much as is necessary. Q. E. D. among mathematicians, is quod erat demonstrandum, *i. e.* which was to be demonstrated; and Q. E. F. quod erat faciendum, *i. e.* which was to be done. Q. D. among grammarians, is quasi dictum, *i. e.* as if it were said.

QUACK, a medical impostor, who "for the good of the public," and "by the blessing of God," undertakes with his powders, potions, or balsam, to cure "all disorders." Thus, ignorance and blasphemy unite in picking the pockets and ruining the constitution of thousands of credulous people in this and other countries. The pretension to infallibility in any one medicine, as a cure for any one disorder, is next to ab-

surd; much more ridiculous is it then to suppose, that any medicine will remove all kinds of complaints.

Every medicine possesses active properties, or it does not. If it be active, it must be dangerous to apply it, indiscriminately, to persons of every age, and without regard to their habits of living. An active medicine, which might be very useful in strengthening a debilitated constitution, would be highly injurious if exhibited in an acute rheumatism, or other inflammatory disorder, and *vice versa*; consequently, an application of the same remedy in all cases can hardly fail of being fatal in some. Should the medicine be inactive, which happily is often the case, it can be of no other utility than to work upon the patient's imagination, and amuse him while his pocket is picked. See Medical Dict.

QUADRANGLE, in geometry, the same with a quadrilateral figure, or one consisting of four sides and four angles. To the class of quadrangles belong the square, parallelogram, trapesium, rhombus, and rhomboides. A square is a regular quadrangle; a trapesium an irregular one.

QUADRANS, the quarter or fourth part of any thing, particularly the *as*, or pound.

QUADRANT, denotes a mathematical instrument, of great service in astronomy, and, consequently, in navigation, for taking the altitudes of the sun and stars; as also for taking angles in surveying. Those chiefly in use, are Adams's, Cole's, Gunter's, Hadley's, Sutton's, or Collins's, the horodictical, the sinical, the astronomical, and the common surveying quadrant. Many of these are made of wood, generally ebony, mounted with ivory; but such are subject to warp, which occasions those made of brass to be preferred for very hot or very cold climates; though their expansion and contraction, under various temperaments, is some drawback on their merits: however, that being the lesser evil, and scarcely ever amounting to more than two or three seconds in the whole arch of the quadrant, cannot be considered as any great defect.

Although these instruments are generally termed quadrants, they are, in truth, but octants, since they occupy but one-eighth of a circumference; but as each of the 45°, they contain on the arch, actually measures two, while taking the observation, they do not receive their designation improperly. We have another description of this instrument, called the sextant, which has 60° marked on its arch, and includes 120° in real measurement. This is peculiarly calculated for the observation of various celestial bodies, so as to ascertain their distances at any particular moment: this often could not be effected by an instrument which embraced only 90°; whereas we rarely find any two planets suitable to the purposes of navigation, at so great a distance as 120°.

The manner in which the quadrant is held, relieves it from the effect of the vessel's motion; although, in the first instance, some difficulty may occur in suiting the body to the rolling, or pitching, of a vessel; yet, in a very short time the operator will become so habituated, as to overcome that trifling impediment.

Hadley's quadrant (or his sextant) is the only instrument, hitherto known, on which the mariner can depend for a correct observation. It may be called the "portable observatory." The first idea of this machine originated with the celebrated Dr. Hooke; it was completed by Sir Isaac Newton, and first offered to the public by Mr. Hadley: however, it has undergone many changes since that time. The great perfection it exhibits, with respect to the accuracy of the angles it defines, is considerably enhanced by the facility with which it may be rectified; so that errors may be avoided: a matter of supreme importance, when we consider the rough usage to which the instrument is subject; and, that an error of one degree in the index makes two in the observation.

Description of Hadley's Quadrant. (Fig. 1, Plate XIII. Miscel.) shows the quadrant, as usually constructed. The following parts compose the instrument. B C, the arc of 45°: A D, the index, moving on a pivot, under the centre of the index-glass, E: which glass is in the exact direction of the index, and stands at right angles upon it. F, the fore-horizon-glass, which receives the reflection from the index-glass. G, the back-horizon-glass. The former stands parallel with the leg, A C; the latter at right angles thereto. K is a pivot, on which three dark glasses, or screens, move, so that any one, or more, may be placed between the index-glass and the horizon-glass, to diminish the lustre of the reflected planet. H and I, the vanes, or sights. The arc, B C, is called the limb, or quadrantal arc; what is beyond 0, is the arc of excess: the residue of the arc usually is graduated up as far as 100°.

A large portion of the lower part of the

index is open, so as to show the gradations on the arc: the lower edge is chamfered, that it may come close down to them, and is there divided into smaller portions: this scale is called the nonius, and shows the smaller divisions in a more correct and obvious manner than could be done by the quadrantal arc, on which each degree is subdivided into no more than three equal parts, of 20′ each. Now the nonius, being divided into 21 equal parts, shows at what portions of the arc the index cuts the division of 20 minutes; therefore it shows every minute.

THE USE OF HADLEY'S QUADRANT.

For the Fore-Observation. Bring the index close to the bottom, so that the middle of the Vernier's scale, or nonius, stand against 0 degrees. Hold the plane of the instrument vertical, with the arch downwards; look through the right-hand hole in the vane, and direct the sight through the transparent part of the horizon-glass, to observe the horizon. If the horizon-line, seen both in the quick-silvered part, and through the transparent part, should coincide, or make one straight line, then is the glass adjusted; but if one of the horizon-lines should stand above the other, slacken the screw in the middle of the lever, backwards or forwards, as there may be occasion, until the lines coincide: fasten the screw in the middle of the lever, and all is ready for use.

To take the Sun's Altitude. Fix the screens above the horizon-glass, using either or both of them, according to the strength of the sun's rays, by turning one or both the frames of those glasses close against the plane or face of the instrument; then your face being turned towards the sun, hold the quadrant by the braces, or by either radius, as is found most convenient, so as to be in a vertical position, with the arch downwards. Put the eye close to the right-hand-hole in the vane, look at the horizon through the transparent part of the horizon-glass, at the same time sliding the index with the left hand, until the image of the sun, seen in the quicksilvered part, falls in with the edge of the horizon, taking either the upper or the under edge of the solar image. Swing your body gently from side to side; and when the edge of the sun is observed not to cut, but to touch the horizon line, like a tangent, the observation is made. Then will the degrees on the arch, reckoning from the end next your body, give the altitude of that edge of the sun which was brought to the horizon. If the lower edge was observed, then sixteen minutes, added to the said degrees, gives the altitude of the sun's centre; but if the upper edge was used, the sixteen minutes must be subtracted.

To take the Altitude of a Star. Look directly up at the star, through the vane, and transparent part of the glass; the index being close to the button: then will the image of the star, by refraction, be seen in the silvered part, right against the star seen through the other part. Move the index forward, and, as the image descends, let the quadrant descend also, to keep it in the silvered part, till it comes down in a line with the horizon, seen through the transparent part, and the observation is made.

To make an Artificial Horizon. Often when the atmosphere is clear above, the horizon is so laden with vapours, as to prevent an observation being taken. In such case, an artificial horizon is to be made thus: fill into any vessel, having a diameter of about three inches, and about half an inch deep, from one to two pounds of quicksilver, on which lay a metal speculum, or a piece of plain glass, whose diameter may be about one-third of an inch less than that of the surface of quicksilver: in this the image of the sun may be seen distinctly. Sling the vessel, so that it may remain level, and take an observation with a stained glass, which will subdue the great brilliancy of the reflection. The observation thus taken, will be as correct as if taken by means of the natural horizon.

As refraction causes each ray of light to assume a curved direction, all objects, when observed, especially by means of instruments, appear with an excess of altitude beyond their actual height. The refractions, to be deducted, follow:

A TABLE OF THE REFRACTION OF THE HEAVENLY BODIES,

TO BE SUBTRACTED FROM THE OBSERVED LATITUDE.

Elevation of the Eye above the Sea, in feet.	Dip of the Horizon of the Sea.	Apparent Altitude.	Refraction.	Apparent Altitude.	Refraction.	Apparent Altitude.	Refraction.	Apparent Altitude.	Refraction.	Apparent Altitude.	Refraction.
		0–1	1–11	0–1	1–11	0–1	1–11	0–1	1–11	0–1	1–11
1	0′.57″	0	33.′ 0	4–50	10.11	10–30	5. 0	26–0	1–56	59.0	0–34
2	1.21	5	32.10	5– 0	9.54	10–45	4.53	27	1–51	60	33
3	1.39	10	31.22	5–10	9.38	11– 0	4.47	28	1–41	61	32
4	1.55	15	30.35	5–20	9.25	11–15	4.40	29	1–40	62	30
5	2. 8	20	29.50	5–30	9. 8	11–30	4.34	30	1–38	63	29
6	2.20	30	28.22	5–40	8.54	11–45	4.29	31	1–35	64	28
7	2.31	32	28. 5	5–50	8.41	12– 0	4.23	32	1–31	65	26
8	2.42	36	27.30	6– 0	8.28	12–20	4.16	33	1–28	66	25
9	2.52	40	27. 0	6–10	8.15	12–40	4. 9	34	1–24	67	24
10	3. 1	50	25.42	6–20	8. 3	13– 0	4. 3	35	1–21	68	23
12	3.18	1– 0	24.29	6–30	7.51	13–20	3.57	36	1–28	69	22
14	3.24	1–10	23.20	6–40	7.40	13–40	3.51	37	1–16	70	21
16	3.49	1–20	22.15	6–50	7.30	14– 0	3.45	38	1–13	71	19
18	4. 3	1–30	21.15	7– 0	7.20	14–20	3.40	39	1–10	72	18
20	4.16	1–40	20.18	7–10	7.11	14–40	3.35	40	1– 8	73	17
22	4.28	1–50	19.25	7–20	7. 2	15– 0	3.30	41	1– 5	74	16
24	4.40	2– 0	18.35	7–30	6.53	15–30	3.24	42	1– 3	75	15
26	4.52	2–10	17.48	7–40	6.45	16– 0	3.17	43	1– 1	76	14
28	5. 3	2–20	17. 4	7–50	6.37	16–30	3.10	44	59	77	13
30	5.14	2–30	16.24	8– 0	6.29	17– 0	3. 4	45	57	78	12
35	5.39	2–40	15.45	8–10	6.22	17–30	2.59	46	55	79	11
40	6. 2	2–50	15. 9	8–20	6.15	18– 0	2.54	47	53	80	10
45	6.24	3– 0	14.36	8–30	6. 8	18–30	2.49	48	51	81	9
50	6.44	3–10	14. 4	8–40	6. 1	19– 0	2.44	49	49	82	8
60	7.23	3–20	13.34	8–50	5.55	19–30	2.39	50	48	83	7
70	7.59	3–30	13. 6	9– 0	5.48	20– 0	2.35	51	46	84	6
80	8.32	3–40	12.40	9–10	5.42	20–30	2.31	52	44	85	5
90	9. 3	3–50	12.15	9–20	5.36	21– 0	2.27	53	43	86	4
100	9.33	4– 0	11.51	9–30	5.31	21–30	2.24	54	41	87	3
		4–10	11.29	9–40	5.25	22– 0	2.20	55	40	88	2
			11. 8	9–50	5.20	23– 0	2.14	56	38	89	1
			10.48	10– 0	5.15	24– 0	2. 7	57	37	90	0
			10.29	10.15	5. 7	25– 0	2. 2	58	35		

The latitude of any place is its distance from the equator, either north or south, and never can exceed ninety degrees. It is found by taking the altitude of the sun, or star, above the horizon, with a quadrant, when on the meridian (*i. e.* due north, or south) of the place of observation. The meridian altitude, corrected for the dip of the horizon, and refraction, and sixteen minutes, the sun's semi-diameter added thereto, gives the altitude of his centre, which, being subtracted from 90°, gives the zenith-distance, or the number of degrees the centre of the object is from the point over your head; with which, and knowing how far the object is to the north or south of the equator, which is called its declination, the latitude is found by the meridian altitude of any celestial object, as follows:

1. If the object be south when observed, call the zenith-distance, south; and *vice versa*. Then, if the zenith-distance, and the

declination, be of contrary names, (that is, if the sun, or star, comes to the meridian in the north, and has south declination, or *per contra),* the zenith-distance, added to the declination, gives the latitude of the place of observation; the designation will be north, or south, according as the declination may be.

2. When the zenith-distance, and the declination, are of the same name, that is, when the sun, or star, comes to the meridian in the north, and has north declination; or, *per contra;* then subtract the lesser from the greater; and the remainder is the latitude.

This general rule decides whether it be north or south. When the declination is greater than the zenith distance, the latitude is of the same name with the declination; but if less, the latitude is on the opposite side of the equator. For further particulars, see LATITUDE.

QUADRANT *of altitude,* is a thin piece of metal, in general applied to the globe, and marked with the degrees, from 0 to 90°: when laid upon the meridian of any place, it shows its latitude, or distance from the equator.

QUADRANT *of a circle,* or the fourth part of its circumference, is contained under two radii standing at right angles. The quadrant contains ninety degrees, and is the parent of various lines of the greatest utility in many branches of the mathematics, such as the lines of chords, of sines, of latitude, &c. See MATHEMATICAL *instruments,* and DIALLING.

QUADRANTS, *gunner's,* are made in various manners, some of them having levels; but the most simple construction, with which we are acquainted, is that made with a staff about a foot in length, having on one side a quadrant, which, by means of a pendulum of metal, shows the exact angle made by the chase, or bore. The staff being put into the muzzle of a mortar, or howitzer, so as to lay, in contact, evenly with its lower side, and the quadrant part being turned down, immediately beyond the muzzle, the pendulum-wire, which is fixed to a small pivot in the right angle, exactly at the centre, whence the quadrant was described, will be kept perpendicular by the weight attached thereto; and will thus indicate the exact elevation of the piece. The point of oscillation, *i. e.* the pivot, must, however, be always kept very smooth; that there may not be the least roughness; else the action would be affected, and the index prove erroneous.

QUADRAT, a mathematical instrument, called also a geometrical square, and line of shadows; it is frequently an additional member on the face of the common quadrant, as also on those of Gunter's and Sutton's quadrant; but we shall describe it by itself, as being a distinct instrument.

It is made of any solid matter, as brass, wood, &c. or of any four plain rules joined together at right angles, as represented in Plate XIII. Miscell. fig. 2, where A is the centre, from which hangs a thread with a small weight at the end, serving as a plummet. Each of the sides, B E and D E, is divided into an hundred equal parts; or, if the sides be long enough to admit of it, into a thousand parts; C and F are two sights, fixed on the side A D. There is, moreover, an index, G H, which, when there is occasion, is joined to the centre, A, in such a manner as that it can move freely round, and remain in any given situation; on this instrument are two sights, K L, perpendicular to the right line going from the centre of the instrument. The side D E is called the upright side, or the line of the direct or upright shadows; and the side B E is termed the reclining side, or the line of the versed or back shadows.

To measure an accessible height, A B, (fig. 3) by the quadrat, let the distance, B D, be measured, which suppose = 96 feet, and let the height of the observer's eye be 6 feet; then holding the instrument with a steady hand, or rather resting it on a support, let it be directed towards the summit A, so that it may be seen clearly through both sights; the perpendicular, or plum-line, mean while hanging free, and touching the surface of the instrument: let now the perpendicular be supposed to cut off on the upper side, K N, 80 equal parts; it is evident, that L K N, A C K, are similar triangles, and (by prop. 4. lib. 6. of Euclid) N K : K L : : K C (*i. e.* B D) : C A; that is, 80 : 100 : : 96 : C A : therefore, by the rule of three, $C A = \frac{96 \times 100}{80} = 120$ feet; and $C B = 6$ feet being added, the whole height B A is 126 feet.

If the observer's distance, as D E, be such, that, when the instrument is directed as formerly towards the summit A, the perpendicular fall on the angle P, and the distance, B E or C G, be 120 feet, C A will also be 120 feet: for P G : G H : : G C :

C A; but P G = G H, therefore G C = C A; that is, C A will be 120 feet, and the whole height B A = 126 feet, as before.

But let the distance B F (*ibid.*) be 300 feet, and the perpendicular or plum-line cut off 40 equal parts from the reclining side. Now, in this case, the angles Q A C, Q Z I, are equal (29. 1. Eucl.) as are also the angles Q Z I, Z I S: therefore the angle Z I S = Q A C; but Z S I = Q C A, as being both right; hence, in the equiangular triangles A C Q, S Z I, we have (by 4. 6. Eucl.) Z S : S I : : C Q : C A; that is, 100 : 40 : : 300 : C A, or C A $= \frac{40 \times 300}{100} = 120$; and by adding 6 feet, the observer's height, the whole height B A will be 126 feet.

To measure any distance, at land or sea, by the quadrat. In this operation the index, A H, is to be applied to the instrument, as was shown in the description; and, by the help of a support, the instrument is to be placed horizontally at the point A (fig. 4) then let it be turned till the remote point F, whose distance is to be measured, be seen through the fixed sights: and bringing the index to be parallel with the other side of the instrument, observe through its sights any accessible mark, B, at a distance; then carrying the instrument to the point B, let the immoveable sights be directed to the first station A, and the sights of the index to the point F. If the index cut the right side of the square, as in K, the proportion will be (by 4. 6.) B R : R K : : B A (the distance of the stations to be measured with a chain): A F, the distance sought. But if the index cut the reclined side of the square, in the point L; then the proportion is L S : S B : : B A : A G, the distance sought; which, accordingly, may be found by the rule of three.

The quadrat may be used without calculation, where the divisions of the square are produced both ways so as to form the area into little squares. Ex. Suppose the thread to fall on 40 in the side of right shadows, and the distance to be measured 20 poles; seek among the little squares for that perpendicular to the side of which is 20 parts from the thread, this perpendicular will cut the side of the square next the centre, in the point 50, which is the height of the required poles. If the thread cut the side of the versed shadows in the point 60, and the distance be 35 poles, count 35 parts on the side of the quadrat from the centre, count also the divisions of the perpendicular from the point 35 to the thread, which will be 21, the height of the tower in poles.

QUADRAT, in printing, a piece of metal cast like the letters, to fill up the void spaces between words, &c. There are quadrats of different sizes, as m quadrats, n quadrats, &c. which are, respectively, of the dimensions of these letters.

QUADRATIC *equation*, in algebra, that wherein the unknown equality is of two dimensions, or raised to the second power. See ALGEBRA.

QUADRATURE, in geometry, denotes the squaring, or reducing a figure to a square. Thus, the finding of a square, which shall contain just as much surface, or area, as a circle, an ellipsis, a triangle, &c. is the quadrature of a circle, ellipsis, &c. The quadrature of rectilinear figures, or method of finding their areas, has been already delivered. See MENSURATION.

But the quadrature of curvilinear spaces, as the circle, ellipsis, parabola, &c. is a matter of much deeper speculation, making a part of the higher geometry; wherein the doctrine of fluxions is of singular use. We shall give an example or two.

Let A R C (Plate XIII. Miscell. fig. 5) be a curve of any kind, whose ordinates R b, C B, are perpendicular to the axis A B. Imagine a right line, b R g, perpendicular to A B, to move parallel to itself from A towards B; and let the velocity thereof, or the fluxion of the absciss, A b, in any proposed position of that line, be denoted by $b d$, then will, $b n$, the rectangle under $b d$ and the ordinate, b R, express the corresponding fluxion of the generating area, A b R; which fluxion, if A $b = x$, and b R $= y$, will be $y \dot{x}$. From whence, by substituting for y or $\dot{x}$, according to the equation of the curve, and taking the fluent, the area itself, A b R, will become known.

But in order to render this still more plain, we shall give some examples, wherein x, y, z, and u are all along put to denote the absciss, ordinate, curve-line, and the area respectively, unless where the contrary is expressly specified. Thus, if the area of a right angled triangle be required; put the base A H (fig 6) $= a$, the perpendicular H M $= b$, and let A B $= x$, be any portion of the base, considered as a flowing quantity; and let B R $= y$ be the ordinate, or perpendicular corresponding. Then because of the similar triangles, A H M and A B R, we shall have $a : b :: x : y$

$= \frac{bx}{a}$. Whence $y\dot{x}$, the fluxion of the area A B R, is, in this case, equal to $\frac{bx\dot{x}}{a}$; and consequently the fluent thereof, or the area itself, $= \frac{bx^2}{2a}$ which, therefore, when $x = a$, and B R coincides with H M, will become $\frac{ab}{2} = \frac{AH \times HM}{2}$ = the area of the whole triangle A H M; as is also demonstrable from the principles of common geometry.

Again, let the curve A R M H, (fig. 7) whose area you would find, be the common parabola; in which case, if A B $= x$, and B R $= y$, and the parameter $= a$; we shall have $y^2 = ax$, and $y = a^{\frac{1}{2}}x^{\frac{1}{2}}$: and therefore, $\dot{u}\ (= y\dot{x}) = a^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}$; whence $u = \frac{2}{3} \times a^{\frac{1}{2}}x^{\frac{3}{2}} = \frac{2}{3}a^{\frac{1}{2}}x^{\frac{1}{2}} \times x = \frac{2}{3}yx = \frac{2}{3} \times AB \times BR$. Hence a parabola is two-thirds of a rectangle of the same base and altitude.

The same conclusion might have been found more easily in terms of y; for $x = \frac{y^2}{a}$, and $\dot{x} = \frac{2y\dot{y}}{a}$; and consequently $\dot{u}\ (= y\dot{x}) = \frac{2y^2\dot{y}}{a}$; whence $u = \frac{2y^3}{3a} = \frac{2y}{3} \times \frac{y^2}{a} = \frac{2y}{3} \times x = \frac{2}{3} \times AB \times BR$, as before.

To determine the area of the hyperbolic curve A M R B, (fig. 8) whose equation is $x^m y^n = a^{m+n}$; whence we have $y = \frac{a^{\frac{m+n}{n}}}{x^{\frac{m}{n}}} = a^{\frac{m+n}{n}} \times x^{\frac{-m}{n}}$; and therefore $\dot{u}\ (= y\dot{x}) = a^{\frac{m+n}{n}} \times x^{\frac{m-n}{n}}\dot{x}$, whose fluent is $u = \frac{a^{\frac{m+n}{n}} \times x^{1-\frac{m}{n}}}{1-\frac{m}{n}} = \frac{na^{\frac{m+n}{n}} \times x^{\frac{n-m}{n}}}{n-m}$; which, when $x = 0$, will also be $= 0$, if n be greater than m; therefore the fluent requires no correction in this case; the area, A M R B, included between the asymptote, A M, and the ordinate B R, being truly defined by $\frac{na^{\frac{m+n}{n}} \times x^{\frac{n-m}{n}}}{n-m}$, as above. But if n be less than m, then the fluent, when $x = 0$, will be infinite, because the index $\frac{n-m}{n}$ being negative, 0 becomes a divisor to na^{m+n}; whence the area, A M R B, will also be infinite.

But here, the area, B R H, comprehended between the ordinate, the curve, and the part, B H, of the asymptote, is finite, and will be truly expressed by $\frac{na^{\frac{m+n}{n}} \times x^{\frac{n-m}{n}}}{m-n}$, the same quantity with its signs changed; for the fluxion of the part A M R B, being $a^{\frac{m+n}{n}} \times x^{\frac{-m}{n}}\dot{x}$, that of its supplement B R H must consequently be $-a^{\frac{m+n}{n}} \times x^{\frac{-m}{n}}\dot{x}$, whereof the fluent is $-\frac{a^{\frac{m+n}{n}} \times x^{1-\frac{m}{n}}}{1-\frac{m}{n}} = \frac{a^{\frac{m+n}{n}} \times x^{\frac{n-m}{n}}}{m-n}$ = the area, B R H, which wants no correction; because when x is infinite and the area B R H $= 0$, the said fluent will also entirely vanish; since the value of $x^{\frac{m-n}{n}}$, which is a divisor to $a^{\frac{m+n}{n}}$, is then infinite.

For further examples see Simpson's Fluxions, vol. i. sect. vii.

Quadrature, in astronomy, that aspect of the moon when she is 90 degrees distant from the sun; or when she is in a middle point of her orbit, between the points of conjunction and opposition, namely, in the first and third quarters.

Quadrature *lines*, are two lines placed on Gunter's sector: they are marked with Q. and 5, 6, 7, 8, 9, 10; of which Q. signifies the side of the square, and the other figures the sides of polygons of 5, 6, 7, &c. sides. S, on the same instrument, stands for the semi-diameter of a circle, and 90 for a line equal to ninety degrees in circumference.

QUADRILATERAL, in geometry, a figure whose perimeter consists of four right lines, making four angles; whence it is also called a quadrangular figure. The quadrilateral figures are either a parallelogram, trapezium, rectangle, square, rhombus, or rhomboides.

QUADRUPEDS, in zoology, a class of land animals, with hairy bodies, and four limbs or legs proceeding from the trunk of their bodies: add to this, that the females of this class are viviparous, or bring forth their young alive, and nourish them with milk from their teats. This class, though still numerous enough, will be considerably lessened in number, by throwing out of it the frog, lizard, and other four-footed amphibious animals. See Amphibia. On the other hand, it will be increased by the admission

of the bat; which, from its having the fore-feet webbed with a membrane, and using them as birds do their wings in flying, has erroneously been ranked among the bird-kind. Linnæus, whose system we have generally followed, subdivides the quadruped class into six orders, which he characterizes from the number, figure, and disposition of their teeth. See MAMMALIA, and NATURAL HISTORY.

QUADRUPLE, a sum or number multiplied by four or taken four times. This word is particularly used for a gold coin worth four times as much as that whereof it is the quadruple.

QUALEA, in botany, a genus of the Monandria Monogynia class and order. Essential character: calyx four-parted; corolla two-petalled; berry. There are two species, viz. Q. rosea, and Q. cærulea. These are both tall trees, growing naturally in the forests of Guiana.

QUAKERS. See FRIENDS.

QUAKERS, by statute 7 and 8 Wil. III. cap. 27, and 8 George I. cap. 6, making and subscribing the declaration of fidelity, mentioned in 1 William and Mary, shall not be liable to the penalty against others refusing to take such oaths; and not subscribing the declaration of fidelity, &c. they are disabled to vote at the election of members of parliament. By 7 and 8 William III. cap. 34, made perpetual by 1 George I. cap. 6, quakers, where an oath is required, are permitted to make a solemn affirmation or declaration of the truth of any fact; but they are not capable of being witnesses in any criminal cause, serving on juries, or bearing any office or place of profit under government, unless they are sworn like other protestants; but this clause does not extend to the freedom of a corporation. By statute 22 George II. cap. 46, an affirmation shall be allowed in all cases (except criminal) where by any act of parliament an oath is required, though no provision is made, for admitting a quaker to make his affirmation.

QUALITY, is defined by Mr. Locke, to be the power in a subject of producing any idea in the mind: thus a snow-ball having the power to produce in us the ideas of white, cold, and round, these powers, as they are in the snow-ball, he calls qualities; and as they are sensations, or perceptions, in our understandings, he calls ideas. It has been demonstrated that every quality that is propagated from a centre, such as light, heat, cold, odour, &c. has its intensity either increased or decreased, in the duplicate ratio of the distances from the centre inversely. So at double the distance from the earth's centre; or from a luminous, or a hot body, the weight, or light, or heat, is but a fourth part, and at three times the distance, it is but a ninth, &c. The great Sir Isaac Newton has laid it down as one of the rules of philosophising, that those qualities which are incapable of being increased or diminished, and which are found to obtain in all bodies upon which experiments could be tried, are to be esteemed universal qualities of all bodies.

QUAMDIU, *se bene gesserit*, as long as he shall behave himself well in his office, is a clause frequently inserted in letters patent of offices, and is inserted in the patent by which the judges are appointed.

QUANTITY, any thing capable of estimation, or mensuration; or which, being compared with another thing of the same kind, may be said to be greater or less than it, equal or unequal to it. Mathematics is the science or doctrine of quantity, which being made up of parts, is capable of being made greater or less. It is increased by addition, and diminished by subtraction; which are therefore the two primary operations that relate to quantity. Hence it is that any quantity may be supposed to enter into algebraic computations two different ways, which have contrary effects, viz. either as an increment or as a decrement.

A quantity that is to be added, is called a positive quantity; and a quantity to be subtracted, is said to be negative. Quantities are said to be like or similar, that are of the same denomination, they are represented by the same letter or letters, equally repeated: but quantities of different denominations, or represented by a different letter or letters, are said to be unlike or dissimilar. A quantity consisting of more than one term is called a compound quantity; whereas that consisting of one term only is denominated a simple quantity.

The quantity of matter in any body, is the product of its density into its bulk; or a quantity arising from the joint consideration of its magnitude and density; as if a body be twice as dense, and take up twice as much space as another, it will be four times as great. This quantity of matter is best discoverable by the absolute weight of bodies.

The quantity of motion in any body is the factum of the velocity into the mass,

or it is a measure arising from the joint consideration of the quantity of matter, and the velocity of the motion of the body; the motion of any whole being the sum or aggregate of the motion in all its several parts. Hence, in a body twice as great as another, moved with an equal velocity, the quantity of motion is double; if the velocity be double also, the quantity of motion will be quadruple. Hence the quantity of motion is the same with what we call the momentum or impetus of a moving body.

QUANTITY, in grammar, an affection of a syllable, whereby its measure, or the time wherein it is pronounced, is ascertained; or that which determines the syllable to be long or short. Quantity is also the object of prosody, and distinguishes verse from prose; and the economy and arrangement of quantities, that is, the distribution of long and short syllables, make what we call the number.

The quantities are distinguished, among grammarians, by the characters ᵕ, short, as pĕr; and ¯, long, as rōs. There is also a common, variable, or dubious quantity; that is, syllables that are one time taken for short ones, and at another time for long ones, as the first syllable in *Atlas*, *patres*, &c. Feet are made up of quantities.

The quantity of syllables is known two ways. 1. By rules for that purpose. And, 2. By authority. The rules for this end are taught by that part of grammar called prosody; the authority made use of in this case is no more than examples from, or the testimony of, approved authors; and is never used but either when the rules are deficient, or when we are unacquainted with them.

QUANTUM *meruit*, is an action on the case, or a count in *assumpsit* grounded upon the promise of another, to pay him for doing any thing, so much as he should deserve or merit.

QUANTUM *valebant*, in like manner is where goods and wares sold are delivered by a tradesman at no certain price, or to be paid for them as much as they are worth in general; and the plantiff is to aver them to be worth so much.

QUARANTINE, a trial which ships undergo when suspected of having on board persons infected with a pestilential disease. Physicians are occasionally consulted on this subject by government; who regulate this unpleasant restriction on the commerce of the country by their judgment, as to the period of time within which the effects of any infection received by any individual on board, would be shown.

The usual quarantine is forty days. This may be ordered by the king, with the advice of the privy-council, at such times, and under such regulations, as he judges proper. Ships ordered on quarantine must repair to the place appointed, and must continue there during the time prescribed, without having any intercourse with the shore, except for necessary provisions, which are conveyed with every possible precaution. When the time is expired, and the goods opened and exposed to the air as directed, if there be no appearance of infection they are admitted to port. Ships infected with the pestilence must proceed to St. Helen's Pool in the Scilly islands, and give notice of their situation to the Custom-house officers, and wait till the king's pleasure be known. Persons giving false information to avoid performing quarantine, or refusing to go to the place appointed, or escaping; also officers appointed to see quarantine performed, deserting their office, neglecting their duty, or giving a false certificate; suffer death as felons. Goods from Turkey, or the Levant, may not be landed without license from the king, or certificate that they have been landed and aired at some foreign port.

QUARE *impedit*, in law, a writ which lies for him that has purchased a manor, with the advowson thereto belonging, against him that disturbs him in the right of his advowson, by presenting a clerk when the church is void.

QUARRY, a place under ground, out of which are got marble, free-stone, slate, lime-stone, or other matters proper for buildings. Quarries of free stone, are in many places opened, and the stone brought out in the following manner: they first dig a hole in the manner of a well, twelve or fourteen feet in diameter, and the rubbish drawn out with a windlass in large osier baskets, they heap up all around; placing their wheel, which is to draw up their stones, upon it. As the hole advances, and their common ladder becomes too short, they apply a particular ladder for the purpose. When they have got through the earth, and are arrived at the first bank or stratum; they begin to apply their wheel and baskets to discharge the stones as fast as they dig through them. In freeing the stone from the bed, they proceed thus: as common stones, at least the softer kinds, have two grains, a cleaving grain, running

parallel with the horizon, and a breaking grain, running perpendicular thereto; they observe by the grain where it will cleave, and there drive in a number of wedges, till they have cleft it from the rest of the rock. This done, they proceed to break it; in order to which applying the ruler to it, they strike a line, and by this cut a little channel with their stone-axe; and in the channel if the stone be three or four feet long, set five or six wedges, driving them in very carefully with gentle blows, and still keeping them equally forward. Having thus broken the stone in length, which they are able to do of any size within half an inch, they apply a square to the straight side, strike a line, and proceed to break it in breadth. This way of managing stone is found vastly preferable to that where they are broken at random: one load of the former being found to do the business of a load and a half of the latter. But it may be observed, that this cleaving grain being generally wanting in the harder kinds of stones, to break up these in the quarries, they have great heavy stone-axes, with which they work down a deep channel into the stone; and into this channel, at the top, lay two iron bars between which they drive their iron wedges.

QUARRY, among glaziers, a pane of glass cut in a diamond form. Quarries are of two kinds, square and long, each of which are of different sizes, expressed by the number of the pieces that make a foot of glass, *viz.* eighths, tenths, twelfths, eighteenths, aed twentieths; but all the sizes are cut to the same angles, the acute angle in the square quarries being 77° 19′, and 67° 21′ in the long ones.

QUART, a measure containing the fourth part of some other measure. The English quart is the fourth part of a gallon, or two pints. See PINT.

QUARTER, the fourth part of any thing, the fractional expression for which is $\frac{1}{4}$. Quarter, in weights, is generally used for the fourth part of an hundred weight, avoirdupois, or twenty-eight pounds. Used as the name of a dry measure, quarter is the fourth part of a ton in weight, or eight bushels.

QUARTER, in law, the fourth part of a year; and hence the days on which these quarters commence, are called quarter-days, *viz.* March 25, or Lady-day; June 24, or Midsummer-day; September 29, or Michaelmas; and December 21, or St. Thomas the apostle's day. On these days rents on leases, &c. are usually reserved to be paid; though December 25, or Christmas-day, is commonly reckoned the last quarter-day.

QUARTER, in astronomy, the fourth part of the Moon's period: thus, from the new Moon to the quadrature is the first quarter; from this to full Moon, the second quarter, &c.

QUARTER, in heraldry, is applied to the parts or members of the first division of a coat that is quartered, or divided into four quarters.

QUARTER *sessions*. The sessions of the peace is a court of record holden before two or more justices, whereof one is of the quorum, for the execution of the authority given them by the commission of the peace, and certain statutes and acts of parliament. The justices keep their sessions in every quarter of the year at least, and for three days if need be; to wit, in the first week after the feast of St. Michael, in the first week after the Epiphany, in the first week after Easter, and in the first week after St. Thomas, and oftener if need be.

Any two justices, one whereof is of the quorum, by the words of the commission of the peace, may issue their precept to the sheriff, to summon a session for the general execution of their authority; and such session, holden at any time within that quarter of a year, is a general quarter-session, and the sheriff must summons a jury under their authority.

There are many offences, which, by particular statutes, belong properly to this jurisdiction, and ought to be prosecuted in this court, as the smaller misdemeanors, not amounting to felony, and especially offences relating to the game, highways, alehouses, bastard children, the settlements and provision of the poor, vagrants, servants' wages, apprentices, and popish recusants. Some of these are proceeded upon by indictment, and others in a summary way, by motion and order, which may, for the most part, unless guarded against by any particular statute, be removed into the Court of King's Bench by certiorari, and be there either quashed or confirmed.

The business done at quarter-sessions is become of the highest importance to the country, and the public are greatly indebted to those magistrates who have sufficient knowledge of law to perform the duties of their office and give their attendance. In Ireland a practising barrister is appointed at each session to assist as

chairman. In England this is not generally the case by law, but barristers are chiefly preferred, and the duty to be performed is so multifarious, that it requires no small skill in law, accompanied with much activity and industry, to execute it justly.

QUARTER *of a ship*, is that part of a ship's hold which lies between the steerage room and the transom.

QUARTERS, *close*, in a ship, those places where the seamen quarter themselves in case of boarding, for their own defence, and for clearing the decks, &c.

QUARTER *masters*, or QUARTEERS, in a man of war, are officers whose business it is to rummage, stow, and trim the ship in the hold; to overlook the steward in his delivery of victuals to the cook, and in pumping or drawing out beer, or the like. They are also to keep their watch duly, in conning the ship, or any other duty.

QUARTER is also used for a division of a city, consisting of several ranges of buildings, &c. separated from some other quarter by a river, great street, &c. Such were formerly the twenty quarters of the city of Paris.

QUARTER, in war, is used in various senses, as for the place allotted to a body of troops to encamp upon: thus they say, the general has extended his quarters a great way, &c. Quarter also signifies the sparing men's lives: thus, it is said, the enemy asked quarter; we gave no quarter.

QUARTER *of an assembly*, is the place of rendezvous, where the troops are to meet, and draw up in a body.

QUARTERS, *head*, is the place where the general of an army has his quarters, which is generally near the centre of the army.

QUARTER *master*, an officer in the army, whose business is to look after the quarters of the soldiers; of which there are several kinds, *viz.* the quarter-master general, whose business is to provide good quarters for the whole army. Quarter-master of horse, he who is to provide quarters for a troop of horse. Quarter-master of foot, he who is to provide quarters for a regiment of foot.

QUARTERS, in a clock, are the little bells that sound the quarters in an hour.

QUARTERS, in building, are those slight upright pieces of timber placed between the puncheons and posts, used to lath upon. These are of two sorts, single and double; the single quarters are sawed to two inches thick, and four inches broad; the double quarters are sawed to four inches square. It is a rule in carpentry, that no quarters be placed at a greater distance than fourteen inches.

QUARTERING, in the sea-language, is disposing the ship's company at an engagement, in such a manner as that each may readily know where his station is, and what he is to do. As some to the master, for the management of the sails; some to assist the gunners in traversing the ordnance; some for plying of the small shot; some to fill powder in the powder-room; others to carry it from thence to the gunners, in cartridges, &c.

The number of men appointed to manage the artillery is in proportion to the nature of the guns, number and condition of the ship's crew. When a ship is well manned so as to fight both sides occasionally; then

	Pounder.		Men.
To a	42	there are	15
	32	....	13
	24	....	11
	18	....	9, &c.

This number may be reduced, if necessary, and yet the guns be well managed.

The number of men appointed to the small arms, on board his Majesty's ships, will be as follows, *viz.*

To a	First rate	150
	Second ditto	120
	Third of 80 guns ...	100
	—— of 70	80
	Fourth of 60	70
	——— of 50	60
	Fifth	50
	Sixth	40
	Sloops of war	30

Lieutenants command the different batteries; the master superintends the movements of the ship; and the boatswain and a number of men, have charge of the rigging, &c.

When a ship under sail goes at large, neither by wind, nor before a wind, but as it were between both, she is said to go quartering.

QUARTERING, in gunnery, is when a piece of ordnance is so traversed that it will shoot on the same line, or on the same point of the compass as the ship's quarter bears.

QUARTERING, in heraldry, is dividing a coat into four or more quarters, or quarterings, by parting, couping, &c. that is by perpendicular and horizontal lines, &c.

Quartering is also applied to the parti-

tions or compartments themselves; that is, to the several coats borne on an escutcheon, or the several divisions made in it, when the arms of several families are placed on the same shield, on account of intermarriages, or the like. Quartering is also used for distinguishing younger brothers from the elder. In blazoning, when the quartering is performed per cross, the two quarters a-top are numbered the first and second; and those at bottom the third and fourth; beginning to tell on the right side. When the quartering is by a saltier, &c. the chief and point are the first and second quarters, the right side the third, and the left the fourth.

QUARTERLY, in heraldry. A person is said to bear quarterly when he bears arms quartered.

QUARTERN, a diminitive of quart, signifying a quarter of a pint.

QUARTZ, in mineralogy, a species of the Flint genus, which is divided into five sub-species, *viz.* the AMETHYST, which see; the rock-crystal; milk-quartz; common-quartz; and prase. The rock-crystal is white, passing to brown through all the intermediate shades. It occurs rarely massive, often in rolled pieces, and often in crystals of different forms. Externally, the crystals are generally splendent, the rolled pieces are only glistening; internally, they are splendent and vitreous. It is harder than glass, and gives vivid sparks when struck against steel. It is brittle, and easily frangible. Specific gravity 2.65 when pure, but when deeply coloured by metallic oxides it is considerably more. If two of the crystals are rubbed together they afford a phosphorescent light, and exhale a peculiar odour. By exposure to the blow-pipe this crystal undergoes no change, except the loss of colour. It remains unaltered even when exposed to a stream of oxygen gas. It is composed of

Silica	93.0
Alumina	6.0
Lime	1
	100

It is found in abundance in the Alps, also in Hungary, Saxony, and in many parts of the British islands. It is used as an article of jewelry, and is very much prized, particularly the wine and orange yellow.

Milk-quartz is sometimes of white colour, but more frequently of a rose red, passing through all the degrees of intensity to a flesh red. It occurs massive: internally shining: sometimes passes to splendent, and is vitreous, inclining a little to resinous. Hard, but yielding to the file; easily frangible, and not very heavy: it is imagined to be composed of silica and oxide of manganese. It is found in beds, but never in veins, in primitive mountains, in Germany, Sweden, Greenland, Siberia, and also in Coll, one of the Hebrides. It is employed in ornamental works, takes a good polish, and when the colour is good the ornaments made of it are very beautiful. It loses its colour by keeping in a warm place.

Common-quartz is commonly of a white or grey colour, though many specimens are brown, yellow, red, &c. It is found massive, disseminated, in blunt edged pieces, in roundish grains, and rolled pieces. It occurs also in crystals of different kinds. Externally, the lustre of the true crystals varies from splendent to glistening: internally, it is shining and vitreous. Fragments angular, and sharp-edged; massive. Occurs commonly unseparated, but often in prismatic distinct concretions, which are straight, transversely streaked. It is hard, brittle, easily frangible. Specific gravity about 2.6. It is infusible, without addition, before the blow-pipe; but when exposed to a stream of oxygen gas it melts into a white porcellanous ball. It occurs abundantly in the mineral kingdom, and found forming whole rocks, also in beds and veins, and is a constituent part of granite, gneiss, mica, slate, &c. It is employed in place of sand in the manufactory of glass, also in the preparation of smalt, and as an ingredient in porcelain and different kinds of earthenware.

Prase is of a leek-green colour, of various degrees of intensity. It occurs generally massive, seldom crystallized; it is hard, difficulty frangible, not very heavy. It is found in Saxony, in Finland, and Siberia; and is sometimes cut and polished for ornamental purposes.

QUASSIA, in botany, so named in memory of Quassi, a negro slave, who discovered the wood of this tree, a genus of the Decandria Monogynia class and order. Natural order of Gruinales, Magnoliæ, Jussieu. Essential character: calyx five-leaved; petals five; nectary five-leaved; perianth five, distant, each having one seed. There are three species, each of which we shall notice in their order. Q. simaruba, is a tree that grows to a considerable height and thickness, with alternate spreading branches; the bark on the trunk of old

trees is black and a little furrowed, that of younger trees is smooth, grey, and marked with broad yellow spots; the wood is hard, white, and without any remarkable taste; leaves numerous, alternate, composed of several leaflets, oblong, or nearly elliptic, sharp at the end, of a deep green colour, placed alternately on very short foot-stalks; flowers on branched spikes, of a yellow colour. Simaruba is a native of South America and the West Indies; in Jamaica it is known by the names of mountain-damson, bitter-damson, and stave-wood. The drug known by the name of quassia is the bark of the roots of this tree, which is rough, scaly, and warted; the inside, when fresh, is a full yellow, when dry it is paler; it has a little smell; the taste is bitter, but not disagreeable; macerated in water, or in rectified spirit, it quickly impregnates them with its bitterness, and with a yellow tincture; the cold infusion in water is rather stronger in taste than the decoction; the latter gets turbid and of a reddish brown as it cools.

Q. amara, grows to the height of several feet, and sends off many strong branches. The wood is of a white colour and light; the bark is thin and grey. It is a native of South America, particularly of Surinam, and also of some of the West Indian islands. The root, bark, and wood of this tree, have all places in the materia medica. The wood is most generally used, and is said to be a tonic, stomachic, antiseptic, and febrifuge.

Q. excelsa, or polygama, is likewise very common in the woodlands of Jamaica. It is a beautiful, tall, and stately tree; some of them being one hundred feet high, and ten feet in circumference. The trunk is straight, smooth, and tapering, sending off its branches towards the top. The outside bark is pretty smooth, and of a light grey, or ash colour. The bark of the roots is of a yellow cast, somewhat like the cortex simaruba. The inner bark is tough, and composed of fine flaxy fibres. The bark of this quassia, but especially the wood, is intensely bitter. The wood is of a yellow colour, tough, but not very hard; it takes a good polish, and is used as flooring. In taste and virtues it is nearly equal to the Q. amara, and frequently sold for the same. Besides its use in medicine, quassia is supposed to be consumed in large quantities by the brewers, to give a bitterish taste to the beer.

QUAVER, in music, a measure of time equal to half a crotchet, or an eighth of a semibreve. The quaver is divided into two semiquavers, and four demisemiquavers.

QUERCITRON, in dying, the internal bark of the quercus nigra; it yields its colour, which is yellow, by infusion to water, and by the common mordants gives a permanent dye. See Dying.

QUERCUS, in botany, the *oak tree*, a genus of the Monoecia Polyandria class and order, Natural order of Amentaceæ. Essential character: male, calyx commonly five-cleft; corolla none; stamina five to ten: female, calyx one-leaved, quite entire, rugged; corolla none; styles two to five; seed one, ovate. There are twenty-six species and many varieties; Q. robur, the common oak, attains to a great size, particularly in woods; singly, it is rather a spreading tree, sending off, horizontally, immense branches, which divide and subdivide considerably; the trunk is covered with a rugged brown bark; leaves alternate, oblong, broader towards the end, the edges deeply sinuate, forming obtuse or rounded lobes, of a dark green colour, five inches in length, two and a half in breadth, they are deciduous, but often remain on the tree till the new buds are ready to burst. The male flowers come out on aments in bundles, from the buds, alternately and singly from the axils of the leaves; they are pendulous, cylindrical, consisting of yellow, short, roundish, scattered bundles of anthers; above the males the aments of female flowers come out, each composed of three or four small reddish florets, placed alternately, having at the base little reddish scales, which afterwards become the cup, forming the rugged external surface of it; acorn ovate, cylindrical, coriaceous, very smooth except at the base, where it appears as if rasped, one-celled, valveless, received at bottom in a hemispherical cup, tubercled on the outside; the germ is three-celled, with two embryos in each cell, fastened to the base. The wood of the oak, when of a good sort, is well known to be hard, tough, tolerably flexible, not easily splintering, strong without being too heavy, and not easily admitting water; for these qualities it is prefered to all other timber for building ships; it would be difficult to enumerate all the uses to which it may be applied. Oak saw-dust is the principle indigenous vegetable used in dying fustian; all the varieties of drabs and different shades of brown are made with oak saw-dust, variously managed and compounded. Oak apples are also used

in dying as a substitute for galls. See Galls.

Q. suber, cork-barked oak, or cork tree: there are two or three varieties of this species, one with a broad leaf, a second with a narrow leaf, both ever green; and one or two which cast their leaves in autumn; the broad-leaved ever-green is the most common; the leaves of this are entire, about two inches long, and an inch and quarter broad, with a little down on their under sides, on short footstalks; these leaves continue green through the winter till May, when they generally fall off just before the new leaves come out; the acorns are very like those of the common oak. The exterior bark is the cork, which is taken from the tree every eight or ten years; there is an interior bark which nourishes them, so that stripping off the outer bark is so far from injuring the trees, that it is necessary to continue them; for when the bark is not taken off, they seldom last longer than fifty or sixty years in health, whereas trees which are barked every eight or ten years will live one hundred and fifty years, or more.

The uses of the cork are well known both by sea and land; the poor people in Spain lay broad planks of it by their bed-side to tread on, as great persons use Turkey and Persian carpets, to defend them from the floor; they frequently line the walls and inside of their houses, built of stone, with this bark, which renders them warm, and corrects the moisture of the air. This tree is a native of the South of Europe.

QUERIA, in botany, so named from Joseph Quer, Professor of Botany at Madrid, a genus of the Triandria Trigynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx five-leaved; corolla none; capsule one-celled; seed one. There are three species.

QUICKSILVER. See Mercury.

QUILLS, are the large feathers taken out of the end of the wings of geese, ostriches, crows, &c. They are denominated from the order in which they are fixed in the wing; the second and third quills being the best for writing, as they have the largest and roundest barrels. Crow quills are chiefly used for drawing. In order to harden a quill that is soft, thrust the barrel into hot ashes, stirring it till it is soft, and then taking it out, press it almost flat upon your knee with the back of a penknife, and afterwards reduce it to a roundness with your fingers. Another method to harden quills is by setting water and alum over the fire, and while it is boiling put in a handful of quills, the barrels only, for a minute, and then lay them by. Large quantities of quills are yearly imported in Britain from Germany and Holland. The goodness of quills is judged by the size of the barrels, but particularly by the weight; hence the denomination of quills of fourteen, fifteen, &c. loths; *viz.* the thousand consisting of twelve hundred quills, weighing fourteen, fifteen, &c. loths. The loth is a German weight, weighing something more than an ounce. Particular attention should be paid, on purchasing quills, that they may not be left-handed, that is, not out of the left wing.

QUILTING, a method of sewing two pieces of silk, linen, or stuff on each other, with wool or cotton between them; by working them all over in the form of chequer or diamond-work, or in flowers. The same name is also given to the stuff so worked.

QUINCHAMALA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Elæagni, Jussieu. Essential character: calyx inferior, five-toothed; corolla tubular, superior; anthers sessile; seed one. There is only one species; *viz.* Q. chilensis, a native of Chili.

QUINCUNX *order*, in gardening, a plantation of trees, disposed originally in a square; and consisting of five trees, one at each corner, and a fifth in the middle: or a quincunx is the figure of a plantation of trees, disposed in several rows, both length and breadthwise, in such a manner, that the first tree in the second row commences in the centre of the square formed by the two first trees in the first row, and the two first in the third, resembling the figure of the five on cards.

QUINDECAGON, in geometry, a plain figure with fifteen sides and fifteen angles; which, if the sides be all equal, is termed a regular quindecagon, and irregular when otherwise. The side of a regular quindecagon inscribed in a circle, is equal in power to the half difference between the side of the equilateral triangle and the side of the pentagon, inscribed in the same circle; also the difference of the perpendiculars let fall on both sides, taken together.

QUINTESSENCE, properly the fifth essence, or the result of five successive distillations. The term is now obselete; but was formerly used to express the highest degree of rectification to which any substance can be brought.

QUINTILE, in astronomy, an aspect of the planets, when they are seventy-two degrees distant from one another, or a fifth part of the zodiac.

QUINTO *Exactus*, in law, the fifth and last call of a defendant who is sued to outlawry; whereupon, if he appears not, he is by the judgment of the coroners returned outlawed.

QUIRE *of Paper*, the quantity of twenty-four or twenty-five sheets.

QUISQUALIS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Veprecula. Thymelææ, Jussieu. Essential character: calyx five-cleft, filiform; petals five; drupe five-cornered. There is but one species; *viz.* Q. indica, a native of the East Indies, China, and Cochinchina.

QUI *tam*, in law, is part of the phrase *quitam pro domino rege quam pro se ipso in hac parte sequitur;* who sues as well for our Lord the King as himself, and denotes an action for a penalty which is given in part to the first person who will sue.

QUIT *Rent*, a small acknowledgment paid in money, so called, because such payment acquitted the tenant from all other services and duties to the lord. It is considered chiefly as an acknowledgment of tenancy and proof of copyhold.

QUOIL, or COIL, in the sea-language, a rope or cable laid up round, one fack or turn over another, so that it may the more easily be stowed out of the way, and also run out free and smooth, without twistings or doublings.

QUOIN, or COIN, on board a ship, a wedge fastened on the deck close to the breech of the carriage of a gun, to keep it firm up to the ship side. Cantic quoins are short three legged quoins put between casks to keep them steady.

QUOINS, in architecture, denote the corners of brick or stone walls. The word is particularly used for the stones in the corners of brick buildings. When these stand out beyond the brick-work, their edges being chamfered off, they are called rustic quoins.

QUOITS, a kind of exercise or game known among the ancients under the name discus.

QUORUM, a word which often occurs in our statutes, and is much used in commissions, both of justices of the peace, and others, and so called from the words of the commission, *quorum unum esse volumus,* of whom we wish that A, B, &c. should be one. All magistrates are now of the quorum.

QUOTIENT, in arithmetic, the number which arises by dividing the dividend by the divisor.

QUO *minus*, in law, is the name of a writ of different sorts, but principally used in the Court of Exchequer, where it gives the title to the common process.

QUO *Warranto*, is in nature of a writ of right for the King, against him who claims or usurps any office, franchise, or liberty, to inquire by what authority he supports his claim, in order to determine the right.

R.

R, OR r, a liquid consonant, being the seventeenth letter of our alphabet. Its sound is formed by a guttural extrusion of the breath, vibrated through the mouth, with a sort of quivering motion of the tongue drawn from the teeth, and cannulated with the tip a little elevated towards the palate. In Greek words it is frequently aspirated with an *h* after it, as in *rhapsody*, *rhetoric*, &c. otherwise it is always followed by a vowel at the beginning of words and syllables.

Used as a numeral, R anciently stood for 80, and with a dash over it, thus $\bar{R}$, for 80,000; but the Greek r, or ρ, signified an hundred. In the prescriptions of physicians, R or ℞ stands for *recipe*, *i. e.* take.

RABBETING, in carpentry, the planning, or cutting of channels or grooves in boards, &c. In ship-carpentry it signifies the letting in of the planks of the ship into the keel; which, in the rake and run of a ship, is hollowed away, that the planks may join the closer.

RABBIT. See LEPUS.

RACCOON. See URSUS.

RACE, in genealogy, a lineage or extraction continued from father to son.

RACEMUS, in botany, a term that properly signifies a cluster of grapes: but scientifically it is used to signify a mode of flowering, in which the flowers placed along a common foot-stalk are furnished with proper foot-stalks, proceeding as lateral branches from the common flower-stalk. This is exemplified in the vine and currant tree.

RACK, an infernal engine of torture, furnished with pullies and chords, &c. for extorting confession from criminals. This instrument is happily banished from almost every civilized state of the world. The trial by the rack was never known to the law of England. It was proposed in the privy council to put Felton, the assassin of the Duke of Buckingham, to the rack, in order to discover his accomplices; but the judges, being consulted, unanimously declared, that no such proceeding could be admitted by the laws of England.

RACK, ARAC, or ARRAC, in commerce, a spirituous liquor made by the Tartars of mare's milk, which is left to be sour, and afterwards distilled twice or thrice. Rack is also a spirituous liquor which the English get from Batavia or Malacca, of which there are three sorts, the one being extracted from the cocoa-tree, the second from rice, and the third from sugar; but the first is the best, and most in use. It is made of the blossom bunch of the cocoa-tree: for which purpose they tie the bunch while it is still wrapped up within its cod, or membrane, with a piece of packthread, and then with a knife make a cross cut in that bunch, a little above the place where it is tied, and adapt a pitcher to it to receive the liquor, which is called toddy, and is vinous, palatable, and sweet: others use a bamboo-cane instead of a pitcher. Having thus drawn the liquor, they let it ferment, and afterwards distil it.

RACK *rent*, the full extended yearly value of the land, &c. let by lease, payable by tenants for life or years.

RACKET, a kind of bat to strike the ball with at tennis; usually consisting of a lattice or net-work of catgut strained very tight in a circle of wood, with a shaft or handle.

RADIANT, or RADIATING *point*, in optics, is any point of a visible object from whence rays proceed.

RADIATION, the act of a body emitting or diffusing rays of light all round, as from a centre.

RADICAL, in general, something that serves as a basis or foundation. In grammar, we give the appellation radical to primitive words, in contradistinction to compounds and derivatives. Algebraists also speak of the radical sign or quantities, which is the character expressing their roots.

RADICAL *vinegar*, in chemistry. When acetate of copper, reduced to powder, is put into a retort and distilled, there comes over a liquid at first nearly colourless and almost insipid, and afterwards a highly concentrated acid. The distillation is to be continued till the bottom of the retort is red hot. What remains in it then is only a powder of the colour of copper. The acid product, which should be received in a vessel by itself, is tinged green by a little copper which passes along with it; but when distilled over again in a gentle heat, it is obtained perfectly colourless and transparent. The acid thus obtained is exceeding pungent and concentrated. It was formerly distinguished by the names of radical vinegar, and vinegar of Venus; it has since been found to be acetous acid combined with a new dose of oxygen, and is called acetic acid.

RADICLE. See PLANTS.

RADIUS, in geometry, the semi-diameter of a circle, or a right line drawn from the centre to the circumference. In trigonometry, the radius is termed the whole sine, or sine of 90 degrees.

RADIX, or *root*, in mathematics, is a certain finite expression or function, which being evolved or expanded, according to certain rules, produces a series. See SERIES. That finite expression or radix, is the value of the infinite series: thus $\frac{1}{3} = .3333$, &c. $\frac{1}{9} = .1111$, &c. In the same way

$$\frac{1}{1+r} = 1 - r + r^2 - r^3 + r^4, \&c.$$

$$\frac{1}{1+1} = 1 - 1 + 1 - 1 + 1, \&c.$$

RAFT, a sort of float, formed by an assemblage of various planks or pieces of timber, fastened together side by side, so as to be conveyed more commodiously to any short distance in a harbour or road than if they were separate. The timber and plank, with which merchant ships are laden, in the different parts of the Baltic, are attached together in this manner, in order to float them off to the shipping.

The same mode is adopted on the Thames in this country, on the Rhine, and on many of the large lakes and rivers in North America.

RAGG, *rowley*, in mineralogy, a class of silicious stones, of a dark grey colour, with many shining crystals, having a granular texture, and acquiring an ochry crust, by exposure to the air. The specific gravity is about 2.8. It becomes somewhat magnetic by being heated in an open fire. In a strong fire it melts without addition, but with more difficulty than basaltes. It consists of

Silica	47.5
Alumina	32.5
Iron	20
	100.0

RAGG *stone*, in some respects similar to the rowley-ragg. The texture is obscurely laminar, or rather fibrous, but the laminæ or fibres consist of a congeries of grains of a quartzy appearance, coarse and rough: it effervesces with acids, and strikes fire with the steel: it contains a portion of mild calcareous earth, and a small portion of iron. It is used as a whetstone for coarse cutting tools. It is found about Newcastle, and in several other parts of England, where there are large rocks of it in the hills.

RAIA, the *ray*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: five spiracles on each side, placed beneath, near the neck; mouth beneath the head, transverse, beset with teeth; head small, pointed, and not distinct from the body; body somewhat rhomboidal. These fishes are found only in the sea, where they feed on whatever animal substances they meet with. They are sometimes of the weight of two hundred pounds. They conceal themselves for the greater part of the winter in the mud or sand of the bottoms, and, indeed, are seldom seen near the surface of the water. The female is larger than the male, and produces her offspring living, and only one at a time; the young extricating itself gradually from its confinement, and remaining sometime attached by the umbilical vessels, after its complete appearance. There are nineteen species.

R. batis, or the skate, is one of the largest of the genus weighing sometimes two hundred pounds, and one of this size is reported to have been served up at St. John's College, Cambridge. It is the most esteemed species of the genus.

R. clavata, or the thorn-back, is much inferior to the skate in size and goodness. It inhabits the Mediterranean and other seas, and is distinguished by its long and curved spines, on its upper surface. The above are rhomboidal.

R. pastinaca, or the sting ray, inhabits the Indian and Mediterranean seas, and its tail is armed with a very long serrated spine, with which it can inflict very formidable wounds, and which it casts off every year. This was formerly supposed to contain the most subtle poison, and ancient naturalists have been extremely elegant and glowing in their descriptions on this subject. It injures, however, only by piercing and laceration, and, to prevent this, the tail is almost always cut off as soon as the fish is caught. These fishes often lie in ambuscade, and seize their prey by surprise, and frequently take it by active and persevering pursuit.

R. torpedo, the torpedo, inhabits the Mediterranean and the North Seas, and grows to the weight of twenty pounds. This fish possesses a strong electrical power, and is capable of giving a very considerable shock through a number of persons forming a communication with it. This power was known to the ancients, but exaggerated by them with all the fables natural to ignorance, and it is only recently that the power has been ascertained to be truly electric. It is conducted by the same substances as electricity, and intercepted by the same. In a minute and a half no fewer than fifty shocks have been received from this animal, when insulated. The shocks delivered by it in air, are nearly four times as strong as those received from it in water. This power, appears to be always voluntarily exercised by the torpedo, which occasionally may be touched and handled, without its causing the slightest agitation. When the fish is irritated, however, this quality is exercised with proportional effect to the degree of irritation, and its exercise is stated, in every instance, to be accompanied by a depression of the eyes. When the animal exerts that benumbing power from which it derives its name, and when it operates by separate and repeated efforts, this is always the case, both in the continued, and in the instantaneous process, the eyes, which are at other times prominent, are withdrawn into their sockets, a circumstance very naturally attaching both to the condensation and discharge of the subtle fluid. Specimens have been

seen of this fish weighing fifty and even eighty pounds. It commonly lies in forty fathom water, and is supposed to stupify its prey by this extraordinary faculty. It is sometimes nearly imbedded in the sands of shallows, and is stated, in these cases to give to any one who happens to tread upon it, an astonishing and overwhelming shock. On dissection, it was found to exhibit no material difference from the general structure of the ray, excepting with respect to the electric or galvanic organs, which have been minutely examined and detailed by the celebrated anatomist, John Hunter. He states them "to be placed on each side of the cranium and gills, reaching thence to each great fin, and extending longitudinally from the anterior extremity of the animal to the transverse cartilage which divides the thorax from the abdomen." From the whole description, it appears, that these organs, as Mr. Shaw observes, constitutes a pair of galvanic batteries, disposed in the form of perpendicular hexagonal columns; while, in the gymnotus electricus, the galvanic battery is disposed lengthwise on the lower part of the animal. It is stated, that the torpedo, in its dying state, communicates shocks in more than usually rapid succession, but in proportional weakness, and in seven minutes, in these circumstances, three hundred and sixty small shocks were distinctly felt. On the same authority (that of Spallanzani) it is reported, that the young torpedo can exercise this power at the moment after its birth, and even possesses it while a fœtus, several of these having been taken from the parent fish, and been found to communicate perceivable shocks, which, however, were more distinctly felt when these animals were insulated on a plate of glass.

RAJANIA, in botany, so named in memory of John Ray, our celebrated naturalist; a genus of the Dioecia Hexandria class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx six-parted; corolla none: female, styles three; germ inferior, three-celled, with two of the cells obliterated; seed one, with one wing. There are seven species; these are climbing plants, by means of the stem twisting towards the left; the root is tuberous; the flowers in axillary spikes or racemes. They are all natives of the West Indies.

RAIL, in architecture, is used in different senses, as for those pieces of timber which lie horizontally between the pannels of wainscot; for those which lie over and under the balusters in balconies, staircases, and the like; and also for those pieces of timber which lie horizontally from post to post in fences, either with poles or without.

RAIL, (see RALLUS) *ortygometra*, in ornithology, a genus of birds of the order of Grallæ, the beak of which is shorter than the toes: it is of a compressed form, and terminated in a point; but the two chaps are equal in length. It is of the size of the common magpie, and is an elegant bird, of a bright-brown colour, variegated with black spots; it is common in rich pastures, where its constant note is *crex, crex*.

RAIN. See METEOROLOGY.

RAIN *gauge*, a machine for measuring the quantity of rain that falls. There are various kinds of rain-gauges: that used at the apartments belonging to the Royal Society at Somerset-house, is thus dercribed. The vessel which receives the rain is a conical funnel, strengthened at the top by a brass ring twelve inches in diameter. The sides of the funnel, and inner lip of the brass ring, are inclined to the horizon in an angle of more than 65°, and the outer lip is an angle of more than 50°, which are such degrees of steepness, that there seems no probability either that any rain which falls within the funnel, or on the inner lip of the ring, shall dash out, or that which falls on the outer lip shall dash into the funnel.

Plate XIII. Misc. fig. 9, represents one of the best construction of rain-gauges. It consists of a hollow cylinder, having within it a cork-ball attached to a wooden stem, which passes through a small opening at the top, on which is placed a large funnel. When this instrument is placed in the open air in a free place, the rain that falls within the circumference of the funnel will run down into the tube, and cause the cork to float; and the quantity of water in the tube may be seen by the height to which the stem of the float is raised. The stem of the float is so graduated, as to show by its divisions the number of perpendicular inches of water which fell on the surface of the earth since the last observation. It is hardly necessary to observe, that after every observation the cylinder must be emptied.

A very simple rain-gauge, and one which will answer all practical purposes, consists of a copper funnel, the area of whose opening is exactly ten square inches: this funnel is fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the

weight in ounces by .173, which gives the depth in inches and parts of an inch. In fixing these gauges, care must be taken that the rain may have free access to them: hence the tops of buildings are usually the best places. When the quantities of rain collected in them at different places are compared, the instruments ought to be fixed at the same heights above the ground at both places, because, at different heights, the quantities are always different, even at the same place.

RAINBOW. The rainbow is a circular image of the sun, variously coloured. It is thus produced: the solar rays, entering the drops of falling rain, are refracted to their further surfaces, and thence, by one or more reflections, transmitted to the eye: at their emergence from the drop, as well as at their entrance, they suffer a refraction, by which the rays are separated into their different colours, and these, therefore, are exhibited to an eye properly placed to receive them. That this is the true account of the formation of the rainbow, appears from the following considerations: 1. That a bow is never seen but when rain is falling, and the sun shining at the same time, and that the sun and bow are always in opposite quarters of the heavens: this every one's experience can testify. 2. That the same appearance can be artificially represented by means of water thrown into the air, when the spectator is placed in a proper position with his back turned to the sun: experiment will show this. 3. That its formation, as above described, can be clearly explained from the properties of light, already demonstrated in the former parts of this dictionary.

Let A B, (Plate XIII. Miscel. fig. 10) be a drop of water, and C D, a pencil of solar rays incident thereon; if all the rays of any one colour, as red, belonging to the pencil, C D, be refracted to the same point, G, and thence reflected, they will fall on the space, R Q, with the same obliquity, and at the same distances from each other, as the refracted rays, if proceeding backward from G, would fall on the space, T S, but these, at their refraction, would emerge into T D, C S, &c. parallel to each other; ∵ the rays, G R, G Q, will emerge from the drop parallel to each other, and therefore will enter an eye properly placed copiously enough to cause a sensation; a red colour will therefore appear in the direction of these rays, and so of others. But if the refracted rays do not meet in the same point, the reflected rays, (fig. 11) I V, P Q, will not fall on the surface at the same distance from each other that P T and I S do, though their obliquity to the surface be equal to that of the latter; therefore the refracted rays will emerge, diverging from each other, and consequently will not enter the eye copiously enough to cause a perception of their colour. It is plain that where the rays of any colour emerge parallel, all these emerging rays will be inclined to the incident rays in the same angle. And by calculation it is found, that the red rays when they emerge parallel to each other, make with the incident rays an angle, A B O, (fig. 12) of 42° 2′, and the violet an angle, A C O, of 40° 17′, and the rays of the other colours, angles greater than the latter, and less than the former.

If through the eye which receives the emerging rays, there be drawn a line, A X, parallel to the incident rays, it will make with the emerging rays of each colour angles, R A X, and V A X, &c. equal to the above. This line, A X, is called the axis of vision. The several drops placed in the lines, A R, A V, &c. will exhibit to the eye at A, the several prismatic colours respectively, as appears from what has been said; and if those lines be supposed to revolve with a conical motion round the axis of vision, it is evident, for the same reason, that all the drops placed in each of the conic surfaces, so generated, will transmit the rays of each colour respectively to the eye, and therefore, that a number of circular, concentric arches of the prismatic colours, adjoining to each other, will be exhibited to the eye. This explanation relates to the interior bow, whose colours, beginning from the outside, are red, orange, &c. as in the prismatic spectrum. This bow can never be seen if the sun be elevated more than 42° 2′ above the horizon; for the horizon, H O, (fig. 13) always makes with the axis of vision, A X, an angle equal to the elevation of the sun, ∵ in the case here stated, the line, A Q, marking the vertex of a rainbow, would fall entirely below the horizon. As the interior bow is formed by one reflection and two refractions, the exterior bow is formed by two reflections and two refractions at the surfaces of the drops of falling rain. If the red rays of any pencil, C D, (fig. 14) of solar rays after refraction intersect each other at R, so that when reflected at T V, they may proceed parallel within the drop, after a second reflec-

tion at XQ, they will proceed to LM, intersecting each other at S, equally distant from XQ, as R is from TV: and as the rays, QT, XV, if they proceeded backward, would, after reflection, so fall on the surface, NO, as to be refracted into air parallel to each other; so XM, QL, falling on the surface precisely in the same circumstances, shall be refracted to the eye parallel to each other, and therefore will enter it copiously enough to cause a perception of their colour, (and so of the rest). The red rays, when emerging parallel after two reflections, are by calculation found to make with the incident rays, and therefore with the axis of vision, an angle of 50° 57′. The violet rays, when emerging parallel, are found to make with their incident rays, and therefore with the axis of vision, an angle of 54° 7′: the other emerging rays meet the axis of vision in the intermediate angles. From hence it is easy to explain the generation of the exterior bow, (fig. 12) in the same manner as that of the interior. It is to be remarked, that the order of colours in the exterior bow is the reverse of that in the interior, and the reason of this appears in the above explanation; for AE, which marks the direction of the violet rays in the outer bow, contains with AX, the axis of vision, a greater angle than AD, which marks the direction of the red rays, contains with the same axis. The reverse is the case in the interior bow. It is evident, (for a reason similar to that given in the case of the interior bow) that an exterior bow cannot be seen when the elevation of the sun is above 54° 7′.

Rainbow, *lunar*. The Moon sometimes also exhibits the phenomenon of an iris, by the refraction of her rays in drops of rain in the night time.

Rainbow, *marine*, the sea bow, is a phenomenon sometimes observed in a much agitated sea, when the wind, sweeping part of the tops of the waves, carries them aloft, so that the rays of the sun are refracted, &c. as in a common shower.

RAISING *pieces*, or Reason *pieces*, in architecture, are pieces that lie under the beams, and over the posts or puncheons.

RAISINS, grapes prepared by suffering them to remain on the vine till they are perfectly ripe, and then drying them in the sun, or by the heat of an oven.

RAKE *of a ship*, is all that part of her hull which hangs over both ends of her keel. That which is before, is called the fore-rake, or rake-forward; and that part which is at the setting on of the sternpost, is called the rake-aft, or afterward.

RAKING, the act of cannonading a ship on the stern or head, so as that the balls shall range the whole length of the decks, which is one of the most dangerous circumstances that can happen in a naval action; this is frequently called raking fore and aft, and is similar to what is termed by engineers enfilading.

RALLUS, the *rail*, in natural history, a genus of birds of the order Grallæ. Generic character: bill slender, slightly compressed, and incurvated; nostrils small; tongue rough at the end; body much compressed; tail very short. There are twenty-two species, of which we shall notice the following:

R. aquaticus, or the water-rail, is frequently to be seen in this island, and is about four ounces and a half in weight. It resides in moist situations, abounding in sedges and reeds, where it finds cover and security. It is timid and solitary, flies with considerable aukwardness with its legs hanging down, and shows great reluctance, even when much pressed by the sportsman and his dogs, to take wing. It runs with wonderful rapidity, and seldom rises in the air till it has fatigued both itself and its pursuers, by an exhausting progress on its feet. It swims with tolerable ease, and where there are any weeds upon the water, will run over them with great lightness. It is migratory, and winters in Africa. Its flesh is good. See Aves, Plate XIII. fig. 1.

R. porzana, or the water crake or skitty. This also is fond of low and marshy grounds in which are covers of reeds and rushes, and in which it shelters itself in security. It is extremely timid and sequestered, and is rarely seen in this island, eluding observation by its perpetual vigilance and lurking habits. Its nest is formed with singular care of matted rushes, and materials which will float on the water, on which it remains tied, by some filaments, to the stalks of reeds, by which it is prevented from being carried away by the tide or current. This bird is in great esteem for the table.

RAM, in zoology, the male of the sheep kind. See Ovis.

Ram, *battering*, in antiquity, a military engine used to batter and beat down the walls of places besieged. The battering ram was of two sorts, the one rude and plain, the other compound. The former

seems to have been no more than a great beam which the soldiers bore on their arms and shoulders, and with one end of it by main force assailed the wall. The compound ram is thus described by Josephus: it is a vast beam, like the mast of a ship, strenghened at one end with a head of iron, something resembling that of a ram, whence it took its name.

RAM's *head*, in a ship, is a great block belonging to the fore and main halliards. It has three shivers in it, into which the halliards are put, and in a hole at the end of it are reeved the ties.

RAMMER *of a gun*, the gun-stick, a rod used in charging of a gun, to drive home the powder, as also the shot and the wad, which keeps the shot from rolling out. The rammer of a great gun is used for the same purpose. It has a round piece of wood at one end, and the other is usually rolled in a piece of sheep skin, fitted to the bore of the piece, and is used to clear her after she has been discharged, which is called sponging the piece.

RAMPANT, in heraldry, a term applied to a lion, leopard, or other beast that stands on his hind legs, and rears up his fore feet in the posture of climbing, shewing only one half his face, as one eye, &c. It is different from salient, in which the beast seems springing forward as if making a sally.

RAMPART, in fortification, is an elevation of earth round a place capable of resisting the cannon of an enemy, and formed into bastions, curtins, &c. A rampart ought to be sloped on both sides, and to be broad enough to allow room for the marching of waggons and cannon, beside that allowed for the parapet which is raised on it: its thickness is generally about ten or twelve fathom, and its height not above three, which is sufficient to cover the houses from the battery of the cannon. The rampart is encompassed with a ditch, and is sometimes lined or fortified on the inside. Upon the rampart the soldiers continually keep guard, and pieces of artillery are planted there for the defence of the place.

RAMPART, in civil architecture, is used for the space left between the wall of a city, and the next houses.

RAMPHASTOS, the *toucan*, in natural history, a genus of birds of the order Picæ. Generic character: bill extremely large, hollow, carinated on the top, and serrated at the edges; nostrils long, narrow, and behind the base of the bill; tongue ciliated. These birds have been met with only in South America, and there merely between the tropics, being totally incapable of sustaining the cold. They subsist on fruits, particularly of the palm tree. They build in the hollows of trees, and generally in recesses previously formed for the same purpose by the woodpecker, their own bill being exquisitely tender. They are easily tamed and familiarized, and several species have been brought to England, where fruits, fish, and flesh, have been promiscuously devoured by them with considerable voracity. Whatever was received by the bill was thrown into the air, and, on its return caught, and without the slightest mastication, or almost compression, instantaneously swallowed. The climate alone appeared to disagree with them. There are seventeen species enumerated by Gmelin, and fifteen by Latham. For the yellow-throated toucan, see Aves, Plate XIII. fig. 2.

RAN, an old English word, denoting open and barefaced robbery: hence has obtained the phrase, "he has taken all he can rap and ran." The word has been defined by law writers: "Ran dicitur aperta rapina quæ negari non potest."

RANA, the *frog*, in natural history, a genus of Amphibia of the order Reptiles. Generic character: body four-footed, tailless, and without any integument but the skin; hind legs longer than the fore. There are thirty-six species, of which the following deserve the chief attention:

R. bufo, the common toad, is found in shady and damp situations throughout Europe, and often is met with in cellars, concealed in recesses and holes, which it sometimes prepares for itself, but generally finds already accommodated to its purpose. In spring it moves towards the water, and lays its ova in a brilliant band of glutinous substance, several feet in length. The ova appear like beads of jet, and in fourteen days these convolved larvæ are developed and swim about, nourishing themselves by insects and vegetable substances, till their tail disappears, and their legs are formed, and they pass from water to land. The toad is always covered with tubercles, is generally of a dark brown colour above, and a light yellow on the lower parts both of the body and limbs. It lives to a considerable age, surviving, in some instances, even twenty years, and the case of a toad, which arrived at the age of forty, is mentioned by Mr. Pennant. This was remarkable, not only for its longevity, but for be-

ing in a great degree domesticated. It was introduced to the table of the family, caught its food, consisting of insects, with great alertness and dexterity, grew to an uncommon size, would approach on being called by a particular name given to it, and regularly resided in a hole under the garden steps. The ideas formerly entertained of venomous qualities possessed by this animal, and on which the writers of almost every age have expatiated with firm belief, are now ascertained to be groundless, and the toad is regarded as an inoffensive animal, at least with respect to mankind, on whom its touch or bite never produces any serious injury. The small lizard appears, after biting the toad, to experience a temporary paralysis; even the mouths of dogs are stated to be somewhat irritated and inflamed, by the exudation in the skin of this animal, in a state of alarm and irritation. But the limpid fluid which it otherwise discharges during this state, is said to be free from even the slightest corrosive quality. The exudation of some other species, however, is considered to be highly acrimonious. The statements which have repeatedly been published of toads found living in large blocks of wood and of stone, with no perceivable inlet for the air, and touched on all sides by the substance in which they were inclosed, appear to savour of the marvellous, and such representations are certainly not to be credited upon light authority. It is ascertained that a toad will live for many weeks, and even months, in a very small case, or under a pan, buried deeply in the earth. A gentleman inclosed three toads in three boxes before the members of the French Academy, and covered these boxes with thick mortar, leaving them in the apartments of that Society, and after eighteen months the boxes were opened, and two of the animals were found still living. The eyes of the toad are remarkable for their clearness and beauty, and excite sensations of a very different nature from that disgust, and even horror, which its general appearance almost universally excites. See Amphibia, Plate II. fig. 2.

R. cornuta, or the horned toad, is distinguished by two sharp horns on its head, or rather by so peculiar a structure of the upper lids of its eyes, as to produce the resemblance of horns. Its mouth is of a most extravagant width, and in the whole list of amphibious animals it is difficult perhaps to point out one equally calculated by deformity and ugliness to excite disgust. It is found only in South America.

R. pipa, or the Surinam toad, is much larger than the common toad, being sometimes seven inches in length. This animal is almost equally loathsome with the last, and is distinguished particularly by this curious deviation from the general course of nature, the exclusion of its young from its back, which contains a variety of cells for their residence, and a certain degree of maturation. It appears, however, that the ova are first deposited on the margin of some stagnant water, and afterwards, with great care, collected on the back of the female, and pressed into the cells, which are at particular seasons opened for their reception, and immediately on receiving them close over them. Here the young from the egg state to that of the tadpole, and from the latter to the form of the perfect animal, and after the expiration of three months from their inclosure, are dislodged in this matured state. In the space of five days one female has been seen to exclude in this manner seventy-five young ones.

R. temporania, or common frog, is met with almost every where throughout Europe, in low and wet situations, where it can procure that food on which it principally subsists, worms and insects. During the heat of summer it generally resides in water, and is able to swim with great dexterity, its hind feet being furnished with strong webs admirably adapted for this exercise, and in winter it remains imbedded in the muddy bottoms of pools, or lodges in deep recesses in their banks in a state of torpor, from which it is revived by the influence of spring. In March it deposits an accumulation of transparent ova, from which, within about a month are hatched tadpoles, every egg in the mean time advancing daily in size, so that before the expiration of this period, these tadpoles may be clearly seen struggling in the viscous fluid which surrounds them. When first hatched they subsist on the remainder of this glutinous fluid. These animals appear to possess little more than a head and tail, and exhibit a singular contrast to the form of the animal which they are destined perfectly to resemble. The internal structure of the old and young is little less different than their external appearance. These animals live to the age of twelve or fifteen years, and do not attain their maturity before their fifth year. They will survive the

amputation of several of their organs, and of consequence must possess a strong principle of vitality. They are fond of basking in the sun, cannot well dispense with water for any considerable time, and are incapable of sustaining rigorous cold. See Amphibia Plate II. fig. 1.

R. esculenta, or green frog, is much larger than the last species, and abounds in many countries of Europe, though but rarely to be found in England. These animals croak so loudly as to be heard at a very great distance, and to produce great annoyance. They are extremely voracious, and will occasionally seize small birds, and chickens and ducks when very young, swallowing them entire. They are in some places much used for food, particularly in France, and thought fittest for the table in the month of June.

R. catesbeiana, or the bull-frog, is found in many regions of North America, and grows to the length of eighteen inches from the nose to the hind feet. Its sounds resemble the lowing of a bull. In Virginia these frogs are supposed to be great purifiers of the water, and a pair of them may generally be seen by any person approaching the public fountains common in that country; but on being thus surprised by the traveller, they make two or three leaps, and plunge into the mouth of the spring, where they are secure from molestation. They are highly rapacious, often commit great depredations on the poultry, swallowing even young geese without considerable difficulty.

R. paradoxa, or the paradoxical frog, is of the size of the common frog of Europe, and is found chiefly in America, and particularly in Surinam. It is remarkable for the circumstance of the tadpole, bearing a greater proportion to the size of the parent animal than in any other species. This proportion, indeed, is truly extraordinary and curious.

R. zebra, or the zebra frog, is a native of Carolina and Virginia, and is by far the largest of the slender bodied frogs. It is of a pale reddish brown, and beautifully marked, transversely, on the back and limbs, with bars of a chesnut colour.

R. arborea, or tree frog, is not found in Great Britain, but is met with in various other parts of Europe, and in elegance and activity is superior to every other European species. In summer it resides in the woods, and haunts the trees in quest of insects, which it approaches on its belly, in the same manner as a cat to a mouse, and at length seizes with an elastic and instantaneous spring. It is particularly noisy on the approach of rain. In winter it takes up its abode in the bottoms of the waters, remaining till the spring in a state of torpor.

RANCIDITY, in chemistry; fixed oils are liable, by keeping, to undergo a change well known by the name of rancidity. They become thick; acquire a brown colour, an acrid taste, and a disagreeable smell. The oil thus altered converts vegetable blues into red, and of course contains an acid. It is believed that this change is owing to the alteration of the foreign substances present in oils, or to the action of those foreign bodies upon the oily matter itself. Several of the fixed oils, when newly extracted, let fall, on standing, a quantity of mucilaginous matter; and from the experiments of Scheele, it appears probable that they always retain less or more of a similar principle.

RANDOM *shot*, in gunnery, is a shot made when the muzzle of a gun is raised above the horizontal line, and is not designed to shoot directly, or point blank. The utmost random of any piece is about ten times as far as the bullet will go point blank. The bullet will go furthest when the piece is mounted to about forty-five degrees above the level range.

RANGE, in gunnery, the path of a bullet, or the line it describes from the mouth of the piece to the point where it lodges. If the piece lie in a line parallel to the horizon, it is called the right or level range: if it be mounted to forty-five degrees, it is said to have the utmost range, all others between 00 and 45° are called the intermediate ranges.

RANK, the order or place allotted a person, suitable to his quality or merit. See PRECEDENCE.

RANK, in war, is a row of soldiers, placed side by side. To double the ranks, is to put two ranks into one. To close the ranks, is to bring the men nearer; and to open them, is to set them further apart.

RANSOM, was the sum formerly given by captains or passengers for the redemption of a vessel captured by pirates. This is now prohibited by statute.

RANUNCULUS, in botany, *crowfoot*, a genus of the Polyandria Polygynia class and order. Natural order of Multisilique, Linnæus. Ranunculaceæ, Jussieu. Essential character: calyx five-leaved; petals five to eight, with a honied pore at the

claw; seeds naked. There are fifty-nine species. R. aconitifolius, aconite leaved crowfoot, is a very handsome species, about three or four feet in height, branched; stems hollow within; leaves large, digitate, three-lobed, divided to the base; segments lanceolate, hirsute, especially at the base; flowers white, terminating each branch; petals roundly serrate. Native of the Alps of Europe. The double flowering variety has been obtained by seeds, and is preserved in many gardens for the beauty of its flowers. By some gardeners it is called fair-maid of France. The Persian crowfoot, or garden ranunculus, has been greatly improved by culture, and many new flowers obtained from seeds, amongst which are several with semidouble flowers, which produce seeds; and from these there are such prodigious varieties of new flowers annually obtained, which are large and of such variety of beautiful colours, as to exceed all other flowers of that season; many of them are finely scented; the roots, when strong, generally produce twenty or thirty flowers upon each; it is a native of the Levant.

RAPE *of women*, is where a man has carnal knowledge of a woman by force, and against her will, which is by our law a capital felony, and subjects the offender to the punishment of death, which is never remitted. By 18 Elizabeth, c. 7, if any person shall, unlawfully and carnally, know and abuse any woman child under the age of ten years, whether with her consent or against it, he shall be punished as for a rape. And it is not a sufficient excuse in the ravisher to prove that she is a common strumpet; for she is still under the protection of the law, and may not be forced. Nor is the offence of a rape mitigated, by showing that the woman at last yielded to the violence, if such her consent were forced by fear of death or duress; nor is it any excuse that she consented after the fact.

Rape is also a name given to a division of a county, and sometimes means the same as a hundred, and at other times signifies a division consisting of several hundreds; thus Sussex is divided into six rapes, every one of which, besides its hundreds, has a castle, a river, and a forest belonging to it. The like parts in other counties are called tithings, lathes, or wapentakes.

RAPHANUS, in botany, *radish*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, Cruciformes, or Cruciferæ. Essential character: calyx closed; silique torose, subarticulate, cylindrical; glands four, two between each shorter stamen and the pistil, and two between the longer stamens and the calyx. There are six species. R. sativus, common garden radish, has a large fleshy, fusiform, annual root; stem upright, thick, much branched and diffused, rough with pellucid bristles; leaves rough; calyx green, rough haired; petals pale violet, with large veins running over them. It is a native of China. There are four varieties of the common radish, *viz.* the long-rooted radish; the small white turnep-rooted or Naples radish; the black Spanish radish; and the large turnep-rooted, or white Spanish radish. The first variety is that which is commonly cultivated in our kitchen gardens for its roots; of this there are several subordinate variations.

RAPHIDIA, in natural history, a genus of insects of the order Neuroptera. Generic character: mouth with a curved toothed horny mandible; thorax long, cylindrical; three stemmata; wings deflected; antennæ filiform, as long as the thorax, the anterior part elongated and cylindrical; four feelers very short, filiform; tail of the female terminated by a large recurved bristle. There are two species, *viz.* the R. ophiosis, a smallish fly with rather large transparent wings, and a narrow thorax, stretching forwards in a remarkable manner; it is found on trees in summer, though but seldom; the pupa resembles the complete insect, except being destitute of wings. R. rotata, mentioned by Gmelin has, by other naturalists, been supposed to be a mere variety of the ophiosis. Dr. Shaw mentions two other species, *viz.* R. cornuta, which in size is equal to one of the larger dragon flies, and is distinguished by its very long horn-like jaws, which extend far beyond the thorax, and are terminated by a bifid tip; the wings are large, reticulated, and semi-transparent. It is a native of North America. R. mantispa, a small species that has the habits of the genus Mantis, and is supposed by some to belong to that genus.

RAREFACTION, in physics, is the making a body to expand or occupy more room or space, without the accession of new matter. It is by rarefaction that gunpowder takes effect; and to the same principle also we owe eolipiles, thermometers, &c. The degree to which air is rarefiable exceeds all imagination; perhaps indeed its degree of expansion is absolutely beyond

all limits. Upon the rarefaction of the air is founded the method of measuring altitudes by the barometer; in all cases of which the rarity of the air is found to be inversely as the force that compresses it, or inversely as the weight of all the air above it at any place.

The open air, in which we breathe, says Sir Isaac Newton, is 8 or 900 times lighter than water, and by consequence 8 or 900 times rarer. And since the air is compressed by the weight of the incumbent atmosphere, and the density of the air is proportionable to the compressing force, it follows by computation, that at the height of about seven English miles from the earth, the air is four times rarer than at the surface of the earth; and at the height of 14 miles, it is 16 times rarer than at the surface of the earth; and at the height of 21, 28, or 35 miles, it is respectively 64, 256, or 1024 times rarer, or thereabouts; and at the height of 70, 140, and 210 miles, it is about 1,000,000, 1,000,000,000,000, or 1,000,000,000,000,000,000, &c.

Mr. Cotes has found, from experiments made with a thermometer, that linseed-oil is rarified in the proportion of 40 to 39 in the heat of the human body; in that of to 15 to 14, in that degree of heat wherein water is made to boil; in the proportion of 15 to 13, in that degree of heat wherein melted tin begins to harden; and finally, in the proportion of 23 to 20, in that degree wherein melted tin arrives at a perfect solidity. The same author discovered, that the rarefaction of the air, in the same degree of heat, is ten times greater than that of the linseed-oil; and the rarefaction of the oil, about fifteen times greater than that of the spirit of wine.

RASANT, or RAZANT, in fortification. Rasant-flank, or line, is that part of the curtain or flank whence the shot exploded rase, or glance, along the surface of the opposite bastion.

RAT. See MUS.

RATCH, or RASH, in clock-work, a sort of wheel having twelve fangs, which serve to lift up the detents every hour, and make the clock strike.

RATCHETS, in a watch, are the small teeth at the bottom of the fusy, or barrel, which stops it in winding up.

RATE, a standard or proportion, by which either the quantity or value of a thing is adjusted.

RATE *of a ship of war* is its order, degree, or distinction, as to magnitude, burden, &c. The rate is usually accounted by the length and breadth of the gun-deck, the number of tons, and the number of men and guns the vessel carries. Of these there are six rates. A first-rate man of war has its gun-deck from 159 to 174 feet in length, and from 44 to 50 feet broad; it contains from 1313 to 1882 tons, has from 706 to 800 men, and carries from 96 to 100 guns. Second rate ships have their gun-decks from 153 to 165 feet long, and from 41 to 46 feet broad; they contain from 1086 to 1482 tons, and carry from 524 to 640 men, and from 84 to 90 guns. Third rates have their gun-decks from 140 to 158 feet in length, from 37 to 42 feet broad; they contain from 871 to 1262 tons; carry from 389 to 476 men, and from 64 to 80 guns. Fourth rates are in length on the gun-decks from 118 to 146 feet, and from 29 to 38 broad; they contain from 448 to 915 tons; carry from 226 to 346 men, and from 48 to 60 guns. Fifth rates have their gun-decks from 100 to 120 feet long, and from 24 to 31 broad; they contain from 259 to 542 tons, and carry from 145 to 190 men, and from 26 to 44 guns. Sixth rates have their gun-decks from 87 to 95 feet long, and from 22 to 25 feet broad; they contain from 152 to 256 tons, carry from 50 to 110 men, and from 16 to 24 guns.

It is to be observed, that the new-built ships are much larger, as well as better, than the old ones of the same rate; whence they double numbers all along; the larger of which express the proportions of the new-built ships, as the less those of the old ones.

RATIO, in mathematics, is the relation which one quantity bears to another in respect of magnitude, the comparison being made by considering how often one contains, or is contained by, the other. Thus, in comparing 6 with 3, we observe that it has a certain magnitude with respect to 3, which it contains twice; again, in comparing it with 2, we see that it has a different relative magnitude, for it contains 2 three times, or it is greater when compared with 2 than it is when compared with 3. The ratio of a to b is usually expressed by two points placed between them, thus, $a : b$; and the former is called the *antecedent* of the ratio, the latter the *consequent*. When one antecedent is the same multiple, part, or parts, of it's consequent, that another antecedent is of its consequent, the ratios are equal. Thus, the ratio of 4 : 6 is equal to the ratio of

$2 : 3$, *i. e.* 4 has the same magnitude when compared with 6, that 2 has when compared with 3, since $\frac{4}{6} = \frac{2}{3}$; the ratio of $a : b$ is equal to the ratio of $c : d$, if $\frac{a}{b} = \frac{c}{d}$, because $\frac{a}{b}$ and $\frac{c}{d}$, represent the multiple, part, or parts, that a is of b, and c of d.

If the terms of a ratio be multiplied or divided by the same quantity, the ratio is not altered. For $\frac{a}{b} = \frac{m\,a}{m\,b}$.

That ratio is greater than another, whose antecedent is the greater multiple, part, or parts, of its consequent. Thus, the ratio of $7 : 4$ is greater than the ratio of $8 : 5$; because $\frac{7}{4}$, or $\frac{35}{20}$ is greater than $\frac{8}{5}$, or $\frac{32}{20}$. These conclusions follow immediately from our idea of ratio.

"A ratio is called a ratio of greater inequality, of less inequality, or of equality, according as the antecedent is greater, less than, or equal to the consequent."

"A ratio of greater inequality is diminished, and of less inequality increased, by adding any quantity to both its terms. If to the terms of the ratio $7 : 4$, 1 be added, it becomes the ratio of $8 : 5$, which is less than the former. And in general, let x be added to the terms of the ratio $a : b$, and it becomes $a + x : b + x$, which is greater or less than the former, according as $\frac{a+x}{b+x}$ is greater or less than $\frac{a}{b}$; or by reducing them to a common denominator, as $\frac{ab + bx}{b.\overline{b+x}}$ is greater or less than $\frac{ab + ax}{b.\overline{b+x}}$; that is, as b is greater or less than a. Hence, a ratio of greater inequality is increased, and of less inequality diminished, by taking from the terms a quantity less than either of them.

If the antecedents of any ratios be multiplied together, and also the consequents, a new ratio results, which is said to be compounded of the former. Thus, $ac : bd$ is said to be compounded of the two $a : b$ and $c : d$. It is also sometimes called the sum of the ratios; and when the ratio $a : b$ is compounded with itself, the resulting ratio, $a^2 : b^2$, is called the double of the ratio of $a : b$, and if three of these ratios be compounded together, the result, $a^3 : b^3$, is called the triple of the first, &c. Also, the ratio of $a : b$ is said to be one third of the ratio of $a^3 : b^3$; and $a^{\frac{1}{m}} : b^{\frac{1}{m}}$ is said to be an m^{th} part of the ratio of $a : b$.

Let the first ratio be $a : 1$; then $a^2 : 1$, $a^3 : 1$, ...$a^n : 1$, are twice, three times, ... n times the first ratio; where n, the index of a, shows what multiple, or part, of the ratio $a^n : 1$, the first ratio, $a : 1$, is. On this account, the indices, 1, 2, 3, ...n, are called measures of the ratios $a^1 : 1$, $a^2 : 1$, $a^3 : 1$, ... $a^n : 1$.

"If the consequent of the preceding ratio be the antecedent of the succeeding one, and any number of such ratios be taken, the ratio, which arises from their composition, is that of the first antecedent to the last consequent." Let $a : b$, $b : c$, $c : d$, &c. be the ratios, the compound ratio is $a \times b \times c : b \times c \times d$; or dividing by $b \times c$, $a : d$.

"A ratio of greater inequality, compounded with another, increases it; and a ratio of less inequality diminishes it." Let the ratio of $x : y$ be compounded with the ratio of $a : b$, and the resulting ratio $ax : by$ is greater or less than the ratio $a : b$, according as $\frac{ax}{by}$ is greater or less than $\frac{a}{b}$; *i. e.* according as x is greater or less than y.

"If the difference between the antecedent and consequent of a ratio be small when compared with either of them, the double of the ratio, or the ratio of their squares, is nearly obtained by doubling this difference."

Let $a + x : a$ be the proposed ratio, where x is small when compared with a; then $a^2 + 2ax + x^2 : a^2$ is the ratio of the squares of the antecedent and consequent; but since x is small when compared with a, x^2 or $x \times x$ is small when compared with $2a \times x$, and much smaller than $a \times a$; therefore, $a^2 + 2ax : a^2$, or $a + 2x : a$ will nearly express the ratio of $a^2 + 2ax + x^2 : a^2$.

Thus the ratio of the square of 1001 to the square of 1000 is nearly $1002 : 1000$; the real ratio is $1002.001 : 1000$, in which the antecedent differs from its approximate value, only by one thousandth part of an unit.

Hence, the ratio of the square root of $a + 2x$ to the square root of a is the ratio $a \times x : a$, nearly; that is, if the difference of two quantities be small with respect to either of them, the ratio of their square

roots is nearly obtained by halving their difference.

In the same manner, $a + 3x : a$; $a + 4x : a$; $a + mx : a$; are nearly equal to the ratios $\overline{a+x}^3 : a^3$; $\overline{a+x}^4 : a^4$; $\overline{a+x}^m : a^m$; if mx be small when compared with a.

Or we may treat the subject differently, thus, ratio is that relation of homogeneous things which determines the quantity of one from the quantity of another, without the intervention of a third. Two numbers, lines, or quantities, A and B, being proposed, their relations one to another may be considered under one of these two heads: 1. How much A exceeds B, or B exceeds A; and this is found by taking A from B, or B from A, and is called arithmetic reason, or ratio. 2. Or how many times, and parts of a time, A contains B, or B contains A; and this is called geometric reason, or ratio; (or, as Euclid defines it, it is the mutual habitude, or respect, of two magnitudes of the same kind, according to quantity; that is, as to how often the one contains, or is contained, in the other) and is found by dividing A by B, or B by A; and here note, that the quantity which is referred to another quantity, is called the antecedent of the ratio; and that to which the other is referred is called the consequent of the ratio; as, in the ratio of A to B, A is the antecedent, and B the consequent. Therefore any quantity, as antecedent, divided by any quantity as a consequent, gives the ratio of that antecedent to the consequent.

Thus the ratio of A to B is $\frac{A}{B}$, but the ratio of B to A is $\frac{B}{A}$; and, in numbers, the ratio of 12 to 4 is $\frac{12}{4} = 3$, or triple; but the ratio of 4 to 12 is $\frac{4}{12} = \frac{1}{3}$, or subtriple.

The quantities, thus compared, must be of the same kind; that is, such which, by multiplication, may be made to exceed one the other, or as these quantities are said to have a ratio between them, which, being multiplied, may be made to exceed one another. Thus a line, how short soever, may be multiplied, that is, produced so long as to exceed in length any given right line, and consequently these may be compared together, and the ratio expressed; but as a line can never, by any multiplication whatever, be made to have breadth, that is, to be made equal to a superficies, how small soever; these can therefore never be compared together, and consequently have no ratio or respect one to another, according to quantity; that is, as to how often the one contains, or is contained in the other.

RATION, in the army, a portion of ammunition, bread, drink, and forage, distributed to each soldier in the army, for his daily subsistence, &c. The horse have rations of hay and oats when they cannot go out to forage. The rations of bread are regulated by weight. The ordinary ration of a foot soldier is a pound and a half of bread per day. The officers have several rations, according to their quality and the number of attendants that they are obliged to keep. When the ration is augmented on occasions of rejoicing, it is called a double ration. The ships' crews have also their rations or allowances of biscuit, pulse, and water, proportioned according to their stock.

RATIONAL, is a word applied to integral, fractional, and mixed numbers: thus we say rational fraction, rational integer, and rational mixed number; for the explanation and doctrine of which, see NUMBER and FRACTION.

Rational is applied to the true horizon, in opposition to the sensible or apparent one. See HORIZON.

RATIONALE, a solution, or account of the principles of some opinion, action, hypothesis, phenomenon, or the like.

RATLINES, or, as the seamen call them, RATLINS, those lines which make the ladder steps to get up the shrouds and puttocks, hence called the ratlins of the shrouds.

RATTLE *snake*. See CROTALUS.

RAVELIN, in fortification, was anciently a flat bastion, placed in the middle of a curtain; but now a detached work, composed only of two faces, which make a saliant angle, without any flanks, and raised before the curtain on the counterscarp of the place. A ravelin is a triangular work resembling the point of a bastion, with the flanks cut off. Its use before a curtain is to cover the opposite flanks of the two next bastions. It is used also to cover a bridge, or a gate, and is always placed without the moat. There are also double ravelins, that serve to cover each other: they are said to be double when they are joined by a curtain.

RAVEN. See CORVUS.

RAUWOLFIA, in botany, so named in

honour of Leonhard Rauwolff, physician at Augsburg, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; berry succulent, two-seeded. There are four species.

RAY, in optics, a beam of light, emitted from a radiant, or luminous body. Rays are defined, by Sir Isaac Newton, to be the least parts of light, whether successive in the same line, or contemporary in several lines. For that light consists of parts of both kinds is evident, since one may stop what comes this moment in any point, and let pass that which comes presently after: now the least light, or part of light, which may be thus stopped, he calls a ray of light.

RAYS *of the Sun*. It has been found by experiment, that there is a very great difference in the heating power of the different rays of light.

It appears, from the experiments of Dr. Herschel, that this heating power increases from the middle of the spectrum to the red ray, and is greatest beyond it, where the rays are invisible. Hence it is inferred that the rays of light and caloric nearly accompany each other, and that the latter are in different proportions in the different coloured rays. They are easily separated from each other, as when the sun's rays are transmitted through a transparent body, the rays of light pass on seemingly undiminished, but the rays of caloric are intercepted. When the sun's rays are directed to an opaque body, the rays of light are reflected, and the rays of caloric are absorbed and retained. This is the case with the light of the moon, which, however much it be concentrated, gives no indication of being accompanied with heat. It has also been shown that the different rays of light produce different chemical effects on the metallic salts and oxides. These effects increase on the opposite direction of the spectrum, from the heating power of the rays. From the middle of the spectrum, towards the violet end, they become more powerful, and produce the greatest effect beyond the visible rays. From these discoveries it appears that the solar rays are of three kinds: 1. Rays which produce heat; 2. Rays which produce colour; and, 3. Rays which deprive metallic substances of their oxygen. The first set of rays is in greatest abundance, or are most powerful towards the red end of the spectrum, and are least refracted. The second set, or those which illuminate objects, are most powerful in the middle of the spectrum. And, the third set produce the greatest effect towards the violet end, where the rays are most refracted. The solar rays pass through transparent bodies without increasing their temperature. The atmosphere, for instance, receives no increase of temperature by transmitting the sun's rays, till these rays are reflected from other bodies, or are communicated to it by bodies which have absorbed them. This is also proved by the sun's rays being transmitted through convex lenses, producing a high degree of temperature when they are concentrated, but giving no increase of temperature to the glass itself. By this method the heat which proceeds from the sun can be greatly increased. Indeed, the intensity of temperature produced in this way is equal to that of the hottest furnace. This is done, either by reflecting the sun's rays from a concave polished mirror, or by concentrating or collecting them by the refractive power of convex lenses, and directing the rays thus concentrated on the combustible body.

REACTION, in physiology, the resistance made by all bodies to the action or impulse of others, that endeavour to change its state whether of motion or rest.

REALGAR, in chemistry. Arsenic, mineralised by sulphur, forms two ores, named orpiment and realgar, the chemical distinction of which is not very accurately determined. That which has been named realgar is of a red colour, sometimes inclining to scarlet, sometimes to orange. It occurs massive, disseminated, and crystallised, in oblique, tetraedral, or hexaedral prisms, generally small and translucent, or semitransparent, with a shining lustre. Its fracture is uneven: it is soft and brittle, and has a specific gravity of 3.2, or 3.3. It exhales before the blow-pipe a white arsenical smoke, with an arsenical and sulphurous odour, and gives a blue flame. It consists of arsenic and sulphur in the proportions of 80 of the former, and 20 of the latter.

REASONING, the exercise of the faculty of the mind called reasoning; or it is an act or operation of the mind, deducing some unknown proposition from other previous ones that are evident and known.

REAUMURIA, in botany, so named in honour of René Antoine Ferchault de Reaumur, a genus of the Polyandria Pentagynia class and order. Natural order of Succulentæ. Ficoideæ, Jussieu. Essential character: calyx six-leaved; petals five; cap-

sule one celled, five-valved, many-seeded. There is but one species, *viz.* R. vermiculata, an annual plant, and a native of the coasts of Egypt, Syria, and Sicily.

RECEIPTS, are acknowledgments in writing of having received a sum of money, or other value. A receipt is either a voucher for an obligation discharged, or one incurred. Receipts for money above 40*s.* must be on stamps; but on the back of a bill of exchange or promissory note which is already stamped, they are good without a further duty. Writing a receipt on a stamp of greater value than the law requires, incurs no penalty, and the receipt is good; but if on a stamp of a lower value, or on unstamped paper, then a receipt is no discharge, and incurs a penalty. The stamp acts are very strict in making every written acknowledgment of the receipt of money, however framed, subject to a stamp, and the party liable to a penalty for want of compliance with the act. The word "settled" to a bill is a receipt; and also a name at the back of a check, or at least these can neither of them be produced; nor any other writing to show a payment made, unless accompanied with a stamp.

RECEIVER, in pneumatics, a glass vessel for containing the thing on which an experiment in the air-pump is to be made. See PNEUMATICS.

RECEIVER. Receiving stolen goods, knowing them to be stolen, is an high misdemeanour at the common law; and by several statutes is made a transportable felony, and, in some particular instances, felony without benefit of clergy. In some cases the receiver may be prosecuted without prosecuting the thief, and he may be a witness against the receiver.

RECEPTACLE, in botany, one of the seven parts of fructification, which, according to Linnæus, is the base which connects or supports the other parts. A proper receptacle obtains different names from the parts of the fructification which supports and connects. When both flower and fruit are supported by it, it is generally stiled the receptacle of the fructification. When the receptacle supports the parts of the flower only, it is called the receptacle of the flower. In such cases, the seed-bud or fruit, which is placed below the receptacle of the flower, has a proper base of its own, which is distinguished by the name of receptacle of the fruit. There are simple flowers, which have the seed-bud placed above the receptacle of the flower, the fruit has a separate receptacle; this is exemplified in the magnolia, tulip-tree, &c. The term receptacle is often used to signify the base to which the seeds are fastened within their inclosure, as in the deadly night-shade.

RECIPE, in medicine, a prescription or remedy, to be taken by a patient; so called because always beginning with the word *recipe, i. e. take;* which is generally denoted by the abbreviature ℞. For the rules proper to be observed in forming recipes, see MATERIA MEDICA, &c.

RECIPROCAL *terms*, among logicians, are those which have the same signification; and consequently are convertible, or may be used for each other.

RECIPROCAL, in arithmetic, is the quotient arising by dividing 1 by any number or quantity, thus the reciprocal of 2 is $\frac{1}{2}$ of 5, it is $\frac{1}{5}$ and generally of a it is $\frac{1}{a}$: hence, the reciprocal of a vulgar fraction is found, by barely making the numerator and denominator mutually change places; thus, the reciprocal of $\frac{1}{2}$ is $\frac{2}{1} = 2$; of $\frac{3}{4}$ it is $\frac{4}{3}$; of $\frac{a}{b}$ it is $\frac{b}{a}$. Hence any quantity being multiplied by its reciprocal, the product is always equal to unity; thus, $\frac{1}{2} \times \frac{2}{1} = 1$; and $\frac{a}{b} \times \frac{b}{a} = \frac{a\,b}{a\,b} = b$.

RECIPROCAL *figures*, in geometry, those which have the antecedents and consequents of the same ratio, in both figures. Thus, in two rectangles, the side A : B :: C : D; or 12 : 4 :: 9 : 3; that is, as much as the side A, in the first rectangle, is longer than B, so much deeper is the side C, in the second rectangle, that the side D in the first; and, consequently the greater length of the one is compensated by the greater breadth or depth of the other; for as the side A is one-fourth longer than C, so B is one-fourth longer than D, and the rectangles of course equal; that is, $A \times D = B \times C$, or $12 \times 3 = 4 \times 9 = 36$. This is the foundation of that capital theorem, *viz.* that the rectangle of the extremes is always equal to that of the means; and, consequently, the reason of the rule of three. Hence it follows, that if any two triangles, parallelograms, prisms, parallelopipeds, pyramids, cones, or cylinders have their bases and altitudes reciprocally proportional, those two figures or solids are equal to each other; and *vice versa*, if they are equal, then their bases and altitudes are reciprocally proportional.

Reciprocal *proportion*, in arithmetic, is when, in four numbers, the fourth is less than the second, by so much as the third is greater than the first; and *vice versa*. This is the foundation of the inverse, or indirect rule of three; thus, $4 : 10 :: 8 : 5$. See Rule. Reciprocal proportion is of great use in determining the laws of motion.

RECIPROCALLY, one quantity is reciprocally as another, when the one is greater in proportion as the other is less; or when the one is proportional to the reciprocal of the other. Thus a is reciprocally as b when a is always proportional to $\frac{1}{b}$. So also in mechanics, to perform any given effect, the less the power is, the greater must be the time in performing it, or as we have formerly observed, what is gained in power is lost in time. If p denote any power or agent, and t the time of performing a given work, then p is as $\frac{1}{t}$, and t is as $\frac{1}{p}$, that is, p and t are reciprocally proportional to each other.

RECITAL, in law, is the rehearsal or making mention, in a deed or writing, of something which has been done before.

RECKONING, or *a Ship's Reckoning*, in navigation, is that account, whereby at any time it may be known where the ship is, and on what course or courses she is to steer, in order to gain her port; and that account, taken from the log-board, is called the dead-reckoning.

RECOGNIZANCE, in law, is an obligation of record, which a man enters into before some court of record, or magistrate duly authorized, with condition to the same particular act; as to appear at the assizes or quarter sessions, to keep the peace, &c. If the party does not comply with it, the recognizance is estreated into the Exchequer. In some cases the court will upon motion respite, and in some discharge the recognizance; but all parties should be careful to apply in good time to the court where the recognizance is to be returned.

RECOIL, or Rebound, the starting backward of a fire-arm, after an explosion.

This term is particularly applicable to pieces of ordnance, which are always subject to a recoil according to the sizes and the charges which they contain. To lessen the recoil of a gun, the platforms are generally made sloping towards the embrasures of the battery.

RECONNOITRE, in military affairs, implies to view and examine the state of things, in order to make a report thereof. Reconnoitring parties are those sent to observe the country, and the enemy, to remark the routes, conveniences, and inconveniences of the first; the position, march, or forces of the second.

RECORD, an act committed to writing in any of the King's courts; during the term wherein it is written, is alterable, being no record; but that term once ended, and the act duly inrolled, it is a record, and of that credit, which admits of no alteration or proof to the contrary.

RECORDARE, or *Recordari Facias*, in law, a writ directed to the sheriff, to remove a cause depending in an inferior court, or court of ancient demesne, hundred, or county, to the King's Bench or Common Pleas.

RECOVERY, in law, the name of a species of conveyance of great effect and much utility. Common recoveries were invented by the ecclesiastics to elude the statutes of mortmain; and afterwards encouraged by the courts at law, in order to put an end to all fettered inheritances, and bar not only all estates tail, but also all remainders and reversions expectant thereon. A common recovery is so far like a fine, that it is a suit or action, either actual or fictitious; and in it, the lands are recovered against the tenant of the freehold; which recovery by a supposed adjudication of the right, binds all persons, and vests a free and absolute fee simple in the recoverer. And a common recovery is now looked upon as the best assurance, except an act of parliament, that purchasers can have.

There must be three persons at least to make a common recovery, a recoverer, a recoveree, and a vouchee. The recoverer is the plaintiff or demandant, that brings the writ of entry. The recoveree is the defendant or tenant of the land, against whom the writ is brought. The vouchee, is he whom the defendant or tenant voucheth or calls to warranty of the land in demand, either to descend the right, or to yield him other lands in value, according to a supposed agreement. And this being by consent and permission of the parties, it is therefore said that a recovery is suffered.

A common recovery may be had of such things, for the most part, as pass by a fine. An use may be raised upon a recovery, as well as upon a fine; and the same rules are generally to be observed and followed for the guiding and directing the uses of a recovery, as are observed for the guidance and

direction of a fine. That is to say, that when a fine is levied, or a recovery is suffered, a deed is made between the parties really interested, which declares the purposes of the fine or recovery, and this deed is called a deed to lead or to declare the uses according as it is made before or after the fine or recovery. To enter at full into the learning of fincs and recoveries would be impossible in a general dictionary. It is sufficient to say that both of them are in the nature of a sham suit, while one of which is compromised and the other carried on to judgment by default between the parties really interested, and the use of them is to enable a married woman to make a good conveyance, and a tenant in tail to turn his estate into an estate in fee, or as it is called, to dock or bar the entail. See FINE and ESTATE.

RECTANGLE, in geometry, the same with a right-angled parallelogram. In arithmetic and algebra, a rectangle signifies the same with factum or product.

RECTANGLED, RECTANGULAR, or RIGHT-ANGLED, appellations given to figures and solids which have one or more right-angles: thus a triangle with one right angle, is termed a rectangled tringle; also parallelograms with right angles, squares, cubes, &c. are rectangular. Solids, as cones, cylinders, &c. are also said to be rectangular, with respect to their situation, when their axis are perpendicular to the plane of the horizon. The ancient geometricians always called the parabola, the rectangular section of a cone.

RECTIFICATION, the art of setting any thing to rights: and hence, to rectify the globes, is to fit them for performing any problem.

RECTIFICATION, in geometry, is the finding a right line, equal in length to a curve. The rectification of curves is a branch of the higher geometry, where the use of the inverse method of fluxions is very conspicuous, of which we shall give an example.

Case I. Let A C G, (Plate Miscel. XIII. fig. 15) be any kind of curve, whose ordinates are parallel to themselves, and perpendicular to the axis A Q. Then if the fluxion of the abciss A M be denoted by M m, or by C n, (equal and parallel to M m) and n S, equal and parallel to C r, be the representation of the corresponding fluxion of the ordinate M C; then will the diagonal C S, touching the curve in C, be the line which the generating point p, would describe were its motion to become uniform at C; which line, therefore, truly expresses the fluxion of the space A C, gone over. Hence, putting A M $= x$, C M $= y$, and A C $= z$; we have $\dot{z}\ (= CS = \sqrt{Cn^2 + Sn^2} = \sqrt{\dot{x}^2 + \dot{y}^2}$; from which, and the equation of the curve, the value of z may be determined. Thus, let the curve proposed be a parabola of any kind, the general equation for which is $x = \frac{y^n}{a^{n-1}}$; and hence $\dot{x} = \frac{ny^{n-1}\dot{y}}{a^{n-1}}$, and therefore $(= \dot{z}\sqrt{\dot{y}^2 + \dot{x}^2}) = \sqrt{\dot{y}^2 + \frac{n^2y^{2n-2}\dot{y}^2}{a^{2n-2}}} = \dot{y} \times \overline{1 + \frac{n^2y^{2n-2}}{a^{2n-2}}}\Big|^{\frac{1}{2}}$; the fluent of which, universally expressed in an infinite series, is $y + \frac{n^2y^{2n-1}}{\overline{2n-1} \times 2a^{2n-2}} - \frac{n^4y^{4n-3}}{\overline{4n-3} \times 8a^{4n-4}} + \frac{n^6y^{6n-5}}{\overline{6n-5} \times 16a^{6n-6}}$, &c. $= z$.

Case II. Let all the ordinates of the proposed curve A R M (fig. 16), be referred to a centre C: then putting the tangent R P (intercepted by the perpendicular CP) $= t$, the arch, B N, of a circle, described about the centre C, $= x$; and the radius C N (or C B) $= a$; we have $\dot{z} : \dot{y} :: y$ (C R) $: t$ (R P); and, consequently, $\dot{z} = \frac{\dot{y}y}{t}$: from whence the value of z may be found, if the relation of y and t is given. But, in other cases, it will be better to work from the following equation, viz. $\dot{z} = \sqrt{\dot{y}^2 + \frac{y^2\dot{x}^2}{a^2}}$, which is thus derived; let the right line C R, be conceived to revolve about the centre C; then since the celerity of the generating point R, in a direction perpendicular to C R, is to ($\dot{x}$) the celerity of the point N, as C B (y) to C N (a), it will therefore be truly represented by $\frac{y\dot{x}}{a}$; which being to ($\dot{y}$) the celerity in the direction of C R, produced as C B (s) : R P (t), it follows that $\frac{y^2\dot{x}^2}{a^2} : \dot{y}^2 :: s^2 : t^2$; whence, by composition, $\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2 : \dot{y}^2 :: s^2 + t^2\ (y^2) : t^2$; therefore $\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2 = \frac{y^2\dot{y}^2}{t^2}$, and consequently $\sqrt{\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2}\ (= \frac{y\dot{y}}{t}) = \dot{z}$. Q.E.D.

But the same conclusion may be more easily deduced from the increments of the flowing quantities: for, if R m, r m, and N n be assumed to represent ($\dot{z}$, $\dot{y}$, $\dot{x}$) any

very small corresponding increments of AR, C R, and B N; then will C N (a) : C R (y) :: $\dot{x}$ (the arch N n) : the similar arch R r = $\frac{y\dot{x}}{a}$. And if the triangle R r m (which, while the point m is returning back to R, approaches continually nearer and nearer to a similitude with C R B) be considered as rectilinear, we shall also obtain $\dot{z}^2$ (= $Rm^2 = Rr^2 + rm^2$) = $\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2$; and $\sqrt{\frac{\dot{y}^2\dot{x}^2}{a^2} + \dot{y}^2}$ (= $\frac{y\dot{y}}{a}$) = $\dot{z}$, as before. See Simpson's "Fluxions."

Rectification, in chemistry, is nothing but the repetition of a distillation, or sublimation several times, in order to render the substance purer, finer, and freer from aqueous or earthy parts.

RECTIFIER, in navigation, an instrument consisting of two parts, which are two circles either laid one upon, or let into, the other, and so fastened together in their centres, that they represent two compasses, one fixed, the other moveable; each of them divided into the thirty-two points of the compass, and three hundred and sixty degrees, and numbered both ways, from the north and the south, ending at the east and west, in ninety degrees.

RECTIFYING *the globe*. See Globe.

RECTORY, in law, is taken for an entire parish-church, with all its rights, glebes, tithes, and other profits whatsoever.

RECTUM, in anatomy, the third and last of the large intestines.

RECURRING *series*, is a series constituted in such a manner, that having taken at pleasure any number of its terms, each following term shall be related to the same number of preceding terms according to a constant law of relation.

RECURVIROSTRA, the *avoset*, in natural history, a genus of birds of the order Grallæ. Generic character: the bill long, very thin, and bending considerably upwards; nostrils narrow and pervious; tongue short; feet palmated; hind toe very short and high. There are three species. We shall notice only that which is found in this island. The R. avosetta, or scooping avoset, is as large as a lapwing, and has extremely long legs; its bill is three inches and a half in length. In winter it is often seen in this kingdom, particularly at the mouth of the Severn, and on the coasts of Suffolk. In the fens of Cambridgeshire these birds are known to breed, and appear often in vast flocks. Their subsistence is on insects and worms, which they procure from the soft, muddy bottoms with their bills. They often wade into the water to the top of their legs, and are able to swim; but are seldom seen swimming, and never, unless at a very small distance from the shore. In France, on the coasts of Bas Poiçtou, their nests are plundered annually of several thousands of eggs, which form a nourishing and valued food for the peasantry of that district. See Aves, Plate XIII. fig. 4.

RECUSANT, a person who refuses to go to church, and worship God after the manner of the church of England, as by law established: to which is annexed the penalty of 20*l.* a month for nonconformity. 23 Elizabeth, c. 1.

RED. See Colour, Dying, Optics, &c.

Red *book*, of the Exchequer, an ancient record, or MS. volume, in the keeping of the King's remembrancer, containing divers miscellaneous tracts relating to the periods before the conquest.

REDDENDUM, a clause in a lease, whereby the rent is reserved to the lessor. See Deed.

REDDLE, *red-chalk*, in mineralogy, a species of the iron genus: its name bespeaks its colour: it soils strongly, and writes; is easily frangible; adheres strongly to the tongue; feels meagre; specific gravity 3.9. Exposed to a red heat, it decrepitates, and becomes black; it may even be melted into a greenish grey spumous enamel. In Silesia it is found in compact limestone: it is principally used for drawing: the coarser kinds are used by the carpenter, the finer by the painter. It is sometimes used in its natural state, and sometimes pulverized, washed, and mixed with gum, and cast into moulds.

REDEMPTION, and Equity *of Redemption*, in law. See Mortgage.

REDOUBT, in fortification, a square work raised without the glacis of the place, about musket-shot from the town; having loop-holes for the small arms to fire through, and surrounded by a ditch. Sometimes they are of earth, having only a defence in front, surrounded by a parapet and ditch. Both the one and the other serve for detached guards to interrupt the enemy's works; and are sometimes made on the angles of the trenches for covering the workmen against the sallies of the garrison. The length of their sides may be about twenty fathoms: their parapets must have

two or three banquettes, and be about nine or ten feet thick. They are sometimes (in a siege) called places of arms.

REDUCTION *of metals*, in chemistry. All metals, even the few that resist the action of heat and air, undergo a similar change when exposed to acids, especially the sulphuric, the nitric, and the muriatic, or a mixture of the two last. All metals, by these means, may be converted into powders, which have no resemblance to the metals from which they were obtained. These powders were formerly called calces; but at present they are better known by the name of oxides. They are of various colours, according to the metal and the treatment, and are frequently manufactured in large quantities to serve as paints. When these oxides are mixed with charcoal powder and heated in a crucible, they lose their earthy appearance, and are changed again into the metals from which they were produced. Oil, tallow, hydrogen gas, and other combustible bodies, may be often substituted for charcoal. By this operation, which is called the reduction of the oxides, the combustible is diminished, and indeed undergoes the very same change as when it is burnt. In the language of Stahl, it loses its phlogiston; and this induced him to conclude that metals are composed of earth and phlogiston. Mr. Davy, as we have seen in other parts of this work, inclines to the opinion that there are only two principles in nature, an inflammable and metallic principle.

REDUCTION. See ARITHMETIC.

REDUCTION *of a figure, design, or draught*, is the making a copy thereof, either larger or smaller than the original; still preserving the form and proportion. The great use of the proportional compasses is the reduction of figures, &c. whence they are called compasses of reduction. There are various methods of reducing figures, the most easy is by means of the pentagraph, or parallelogram; but this has its defects. See PENTAGRAPH.

REE, REIS, or RES, a little Portuguese copper coin.

REED, an ancient Jewish measure. See MEASURE.

REED, or the *Common* REED, in botany, *arundo*. See ARUNDO.

REEF, a term in navigation. When there is a great gale of wind, they commonly roll up part of the sail below, that by this means it may become the narrower, and not draw so much wind; which contracting or taking up the sail they call a reef, or reefing the sail: so also when a top-mast is sprung, as they call it, that is, when it is cracked, or almost broken in the cap, they cut off the lower piece that was nearly broken off, and setting the other part, now much shorter, in the step again, they call it a reefed top-mast. The term "reef" implies also a chain of rocks lying near the surface of the water.

REEL, in the manufactories, a machine serving for the office of reeling. There are various kinds of reels, some very simple, others very complex. Of the former kinds those most in use are, 1. A little reel held in the hand, consisting of three pieces of wood, the biggest and longest whereof (which does not exceed a foot and a half in length, and one-fourth of an inch in diameter) is traversed by two other pieces disposed different ways. 2. The common reel, or windlass, which turns upon a pivot, and has four flights traversed by long pins or sticks, whereon the skein to be reeled is put, and which are drawn closer or opened wider, according to the skein.

REELING, in the manufactories, the winding of thread, silk, cotton, or the like, into a skein, or upon a bottom, to prevent its entangling. It is also used for the charging or discharging of bobbins or quills, to use them in the manufacture of different stuffs, as thread, silk, cotton, &c. Reeling is performed different ways, and on different engines.

RE-ENTRY, in law, signifies the resuming or retaking a possession in land lately lost.

REFERENCE, in law, is where a matter is referred by the Court of Chancery to a master, and by the courts at law to a prothonotary, or secondary, to examine and report to the court. Reference also signifies where a matter in dispute is referred to the decision of an arbitrator. This is done either by parol agreement, or by bond, or upon a suit, in which latter case the party has a rule of court, that the party against whom the award is made shall perform it, and then he may move to have an attachment against him if he does not perform it. By statute also this may be done, where the parties agree that the award should be made a rule of court, although there is no suit.

REFINING. See ASSAYING.

REFLECTING *circle*, an astronomical instrument for measuring angles. It is called reflecting from its property, in common with the Hadley's quadrant (of which it is a modification) of observing one of the

objects of the angle to be measured by distinct vision, and the other by reflection of plane mirrors. The first instrument of this kind was invented by Tobias Mayers, in 1770, a celebrated astronomer of Gottingen, who calculated the lunar and solar tables for determining the longitude at sea, for which a reward of 3,000*l.* was given by the board of longitude. In making use of these tables he found that the Hadley's quadrants, though made by the first artists of that time, were not divided with sufficient accuracy for his purpose; he therefore contrived the reflecting and repeating circle; to comprehend which, the reader must turn to our article QUADRANT, by Hadley, from which this instrument differs principally, in being a whole circle of divisions instead of an octant; and is so contrived, that when an observation has been made, it is repeated upon a fresh portion of the divisions, then a third time, a fourth, and so on as many times as is necessary; the observation is then read off, and the product is divided by the number of observations made so as to take a mean of the errors there may be in any part of the divisions on the circle. This contrivance, though useful, was found so tedious, in taking so many observations, that it was laid aside in favour of the Hadley's quadrant, to which in point of accuracy it was really superior.

For the particular description of this instrument we must refer our readers to a work, entitled, "Tabula Motum Solis et Lunæ," by Tobias Mayer, London, 1770. This instrument received an improvement from the Chevalier de Borda, at Paris, which rendered its operation much more simple; but it was not until the year 1796 that the instrument became much used in the British navy, when it was new modelled by Mr. Edward Troughton, and the objections to the former instruments done away. We have obtained permission from this gentleman to make a drawing of this instrument (see Plate Reflecting Circle) where (fig. 1) is a plan of the divided side of the instrument, (and fig. 2) a perspective view of its upper side. A A, in both figures, is a circle of brass, with a narrow ring of silver let into a circular groove in it, as is seen in fig. 1 on which silver the divisions are made. B B B are three arms carrying verniers at their ends, they are all cast in one piece, and screwed to a truly turned steel axis, fitting into a tube, which is screwed to the centre of the circle (this tube cannot be seen in the plan but is denoted by *a* in fig. 2) the index glass, *b*, which is a plane silvered mirror, is fastened to the other end of this axis by three screws in such a position that the centre line of the steel axis it is fixed to, if produced, would exactly coincide with the plane of the silvered surface of the mirror, and consequently that the plane of the mirror produced passes through the centre of the circle A A, perpendicular to its plane.

To the upper end of the tube, *a* (fig. 2) a crooked plate of brass, *d d*, is fastened, and connects it with two other tubes, *e* and *f*, whose lower ends are fixed to the cross bar frame of the circle, one of these, *f*, has the mirror, *h*, called the object glass placed on it; the other has a telescope, *k*, fixed to it directed to the object glass, *h*. The instrument is held, when in use, by handles adapted to different occasions, of which there are four; two perpendicular and two parallel to the plane of the circle; of the latter, *e*, is one on the upper side, supported by a small pillar coming from the intersection of two of the bars of the frame, and steadied by entering the tube, *a*, the other handle is at the divided side of the circle, and is fastened to the circle at the upper side, in the same manner as *e*; by a crooked hollow tube, G, going round the circle; of the other two handles, one *m*, is, above the circle, screwed into a cock fixed to it, so that it is perpendicular to the centre of the circle, it comes over the index glass, but does not touch it. The other handle, is screwed into the handle of the crooked tube, G, so as to be in the same line with the upper handle *m*; *o* are three dark glasses, between the index and horizon glasses, turning on a joint, so as to be put out of the way when necessary, or any one or two of them can be turned in the line of the telescope to darken the light, more or less, in observations of the sun; *p*, are three other glasses supported by a small pillar behind the horizon glass, which can also be turned back as is necessary. The telescope is screwed into a brass ring, *r*, this is supported by a square piece of brass, tapped at the corners, so as to form a screw; and by turning, *s*, a nut upon a screw, the telescope can be raised or lowered parallel to itself; there is also an adjustment to bring the line of collimation of the telescope to be parallel to the plan of the circle.

The circle is divided on the silver ring shown in the plan, into 720 parts, each of which answers to a degree, as this instrument measures double the angle shown upon

the arc, the same as the Hadley's quadrant, these are subdivided into three, each of which will be twenty minutes. The verniers include fifty-nine of these divisions, and are divided into sixty, the coincidences of these will subdivide each original division of the circle into sixty parts, each equal to twenty seconds. The arm on which the vernier, D, is fixed, has a clamp at its end to fasten it to the circle; and a fine screw, *x*, to move it slowly a small quantity after it is clamped.

We shall now describe the manner of making an observation, by this instrument, of the angle between two objects, nearly in the same horizontal plane, we suppose all the adjustments of the instrument to be perfect; the observer first holds the instrument in his right hand, by the handle screwed to the lower handle of the tube G, he looks through the telescope, *k*, and unsilvered part of the horizon glass, *h*, and directs it to one of the objects which will be in the dotted line, *kg*, he then turns the index and index glass, *b*, by its arm D (which must be unclamped) until the other object in the line, *y b*, is reflected from *b* to *h*, and from *h* by the silvered part of the glass, into the line *kg*, in which is placed the observer's eye; he then clamps the arm, D, and gently turns the screws, *x*, backwards or forwards until the reflected image of the object in the line *y*, and the other object seen through the telescope, both exactly cover one another. The observation is now half made, and the observer reads off and writes down the degrees, minutes, and seconds, of each vernier, he then inverts the instrument holding it by the handle, *m*, and directs the telescope to the object, in the line *yb*, and brings the reflected image of the object, in the line *kg*, into view, by turning round the index and index glass the same as before; the observation is then read off and registered. To determine the angle measured, a mean of the products of both observations must be taken, this is the angle between the lines, *y b* and *kg*. A small microscope, M, in the plan, is used to examine the verniers, and it can be applied to either verniers as required.

The dark glasses, *o p*, are only wanted in observing the sun or moon.

It is evident that by inverting the instrument, as we have described, the index error is of no consequence, as it will be always more in one observation and less in the other.

REFLECTION. As the rays of light are reflected by polished surfaces, so it is found that the rays of caloric have the same property. The Swedish chemist Scheele discovered, that the angle of reflection of the rays of caloric is equal to the angle of incidence. This has been more fully established by Dr. Herschel. Some very interesting experiments were made by Professor Pictet of Geneva, which proved the same thing.

These experiments were conducted in the following manner. Two concave mirrors of tin, of nine inches focus, were placed at the distance of twelve feet two inches from each other. In the focus of the one was placed the bulb of a thermometer, and in that of the other a ball of iron two inches in diameter, which was just heated so as not to be visible in the dark. In the space of six minutes the thermometer rose 22°. A similar effect was produced by substituting a lighted candle in place of the ball of iron. Supposing that both the light and heat acted in the last experiment, he interposed between the two mirrors a plate of glass, with the view of separating the rays of light from those of caloric. The rays of caloric were thus interrupted by the plate of glass, but the rays of light were not perceptibly diminished. In nine minutes the thermometer sunk 14°; and in seven minutes after the glass was removed, it rose about 12°. He therefore justly concluded, that the caloric reflected by the mirror, was the cause of the rise of the thermometer. He made another experiment, substituting boiling water in a glass vessel in place of the iron ball; and when the apparatus was adjusted, and a screen of silk which had been placed between the two mirrors removed, the thermometer rose 3°; namely, from 47° to 50°. The experiments were varied by removing the tin mirrors to the distance of 90 inches from each other. The glass vessel, with boiling water, was placed in one focus, and a sensible thermometer in the other. In the middle space between the mirrors, there was suspended a common glass mirror, so that either side could be turned towards the glass vessel. When the polished side of this mirror was turned towards the glass vessel, the thermometer rose only five-tenths of a degree; but when the other side, which was darkened, was turned towards the glass vessel, the thermometer rose 3° 5′. And in another experiment performed in the same way, the thermometer rose 3° when the polished side of the mirror was turned to the glass

vessel, and 9° when the other side was turned. These experiments show clearly, that the rays of caloric are reflected from polished surfaces, as well as the rays of light. Transparent bodies have the power of refracting the rays of caloric, as well as those of light. They differ also in their refrangibility. So far as experiment goes, the most of the rays of caloric are less refrangible than the red rays of light. The experiments of Dr. Herschel show, that the rays of caloric, from hot or burning bodies, as hot iron, hot water, fires and candles, are refrangible, as well as the rays of caloric which are emitted by the sun. Whether all transparent bodies have the power of transmitting these rays, or what is the difference in the refractive power of these bodies is not yet known.

The light which proceeds from the sun seems to be composed of three distinct substances. Scheele discovered, that a glass mirror held before the fire, reflected the rays of light, but not the rays of caloric; but when a metallic mirror was placed in the same situation, both heat and light were reflected. The mirror of glass became hot in a short time, but no change of temperature took place on the metallic mirror. This experiment shows that the glass mirror absorbed the rays of caloric, and reflected those of light; while the metallic mirror, suffering no change of temperature, reflected both. And if a plate of glass be held before a burning body, the rays of light are not sensibly interrupted, but the rays of caloric are intercepted; for no sensible heat is observed on the opposite side of the glass; but when the glass has reached a proper degree of temperature, the rays of caloric are transmitted with the same facility as those of light. And thus the rays of light and caloric may be separated. But the curious experiments of Dr. Herschel have clearly proved, that the invisible rays which are emitted by the sun, have the greatest heating power. In these experiments, the different coloured rays were thrown on the bulb of a very delicate thermometer, and their heating power was observed. The heating power of the violet, green, and red rays, were found to be to each other as the following numbers:

Violet	16.0
Green	22.4
Red	55.0

The heating power of the most refrangible rays was least, and this power increases as the refrangibility diminishes. The red ray, therefore, has the greatest heating power, and the violet, which is the most refrangible, the least. The illuminating power, it has been already observed, is greatest in the middle of the spectrum, and it diminishes towards both extremities, but the heating power, which is least at the violet end, increases from that to the red extremity; and when the thermometer was placed beyond the limit of the red ray, it rose still higher than in the red ray, which has the greatest heating power in the spectrum. The heating power of these invisible rays was greatest at the distance of half an inch beyond the red ray, but it was sensible at the distance of one inch and a half. See Optics.

REFORMATION, in church history, is that amazing change in the religion and politics of a great part of Europe which began to take place in the early part of the sixteenth century. An event of such magnitude, with which the progress of the arts and universal learning is so intimately connected, demands a more enlarged and detailed account than the prescribed limits of our work will admit. It would, nevertheless, be highly improper wholly to omit the notice of so very important an era in the history of Europe.

At a time when the peace and harmony of the Romish Church seemed fully established, and when the authority of the Holy See had just received a most signal triumph by the labours of the Council of the Lateran; when the address and perseverance of Leo the Tenth had surmounted a thousand difficulties, and given peace to his dominions; when Rome had begun once more to assume its ancient grandeur, and was again become the centre of genius, letters, and the arts; when the dark clouds of the middle ages were scattered before the rays of science, and the light of genius had begun to illumine the moral horizon, the attention of the whole Christian world was directed to an event that threatened nothing less than the speedy ruin of the Papal authority, and the complete demolition of that fabric of religious magnificence which the labours of myriads had united to raise, and which the lapse of centuries had left rather established than impaired. It is curious to reflect, that what bid fair to have been the glory and security of the church, conspired to her destruction, and threatened her total overthrow. Leo the Tenth, in aiming to enhance the glory

of his pontificate by the encouragement of literature and the patronage of the arts, was fostering in his bosom an enemy to destroy his peace and degrade his power. The seeds of learning which his father, Lorenzo de' Medici, had sown, and he so plentifully watered, sprung up to choak his pleasures, and reward him with trouble. No sooner had the human mind begun to be emancipated from its slavery, than it employed its newly restored liberty in bold and presumptuous investigations into the conduct of the Roman Pontiffs, the extravagancies of the Papal court, the foundations of church governments, and the truth of established doctrines. The errors and misconduct of the clergy were exposed to the shafts of ridicule and the remonstrances of reason. The hardy and intrepid genius of Dante, which placed the vicars of Christ in the infernal regions, lighted up the fire of Petrarca, and encouraged him to identify the court of Rome with that of ancient Babylon. He made the vices and errors of the Church the subject of his sonnets, and the constant theme of his abuse. Protected by their genius, and respected for their character, these two great men not only escaped the censures of the Holy See, but emboldened the populace to question the infallibility of a church which had nothing but luxury in its train, and learning for its boast. The entertaining work of Boccaccio exposed the debaucheries of the religious, and opened the eyes of the people; and the emancipation of the human race, from the ignominious shackles of ignorance and priestcraft, was hastened by the celebrated *Facetiæ* of Poggio, and the writings of Burchiello, Pulci, and Franco. To the light which these men threw upon the corruptions of the church, and the licentiousness of the Holy See, the patronage of painters, sculptors, and poets, and the protection and maintenance of buffoons and jesters, afforded but a poor defence. Leo X. loved and admired men of learning, notwithstanding their learning was often employed to expose his extravagancies, and endanger the church.

These exposures had begun to be made during the pontificate of Sixtus IV. and that Pope, and his immediate successors, less remiss to the concerns of the church than Leo X. had taken some measures to ward off the danger; but instead of applying the only preventative, by reforming their morals and their lives, the heads of the church sought to stifle investigation by threatenings and punishment. Several very severe restrictions had been laid upon the publication of those works which had a tendency to open the eyes of the people, and expose the errors and vices of the church. These restrictions were, however, in a great measure neglected, by the ardent love of literature which so eminently characterised the conduct of Leo X. That pontiff forgot even his own safety amidst poets, painters, sculptors, wits, and entertainments.

What tended also to pave the way for the reformation, was the rage which at that time prevailed among the learned for Grecian literature and the Pagan mythology. The barbarous latinity of the middle ages gave way to the refined beauties of poetry and classical learning. The paganism of Cicero, and the beauties of Virgil, were made to illustrate and adorn the sublime mysteries of the Christian faith; and Jupiter, Apollo, and Diana, were deemed fit representatives of the persons of the Blessed Trinity, and luminous illustrations of Christian platonism. The doctrine of atonement, by the sufferings of Christ, was explained and enforced by the examples of the Decii and of Curtius; of Cecrops, Menæcius, and Iphigenia; of Socrates and Phocion; of Epaminondas, Scipio, and Aristides. The doctrines and practices of Paganism being thus honoured by the ministers of the church, no wonder that the poets, particularly Pontano, Sanazzaro, and Marullus, should constantly endeavour to adorn even their sacred poems, with a reference to the mythology of Greece and Rome.

With this mixture of Paganism and Christianity, the mysteries of the Platonic philosophy were incorporated. Those refinements of the Platonists, which were so ingeniously infused into the devotion of Lorenzo de' Medici, were propagated among the learned by the labours of Marsilio Ficino, of Pico of Mirandula, of his nephew Gian-Francesco, of Girolamo Benivieni, and others.

The liberties thus taken with the Christian faith, and with the peculiar dogmas of the Romish church, naturally begat a degree of scepticism in the minds of those by whom they were indulged; and from them it spread, more or less, over the minds of the multitude, and prepared the way for a general reformation in the creed and discipline of the church.

At length the danger arising from these unbounded speculations became too evident to pass any longer unnoticed; accordingly, in the eighth session of the Council of the Lateran, several decrees were passed

tending to restrain ecclesiastical students in their pursuits relative to poetry and philosophy; but these restraints and prohibitions were made too late: a spirit of speculation and research had gone abroad, and it was not to be checked by decrees and councils, fulminations and threats.

In addition to the causes of the reformation which we have just enumerated, there were others more obvious, which are said to have been "the long schism of the Church of Rome in the fourteenth century; the misconduct of Alexander VI. and of Julius II.; the encroachments of the clergy on the rights of the laity; the venality of the Roman court; and above all, perhaps, the general progress of liberal studies, and the happy invention of the art of printing."

The spirit of inquiry, aided by the light of science and the invention of printing, had more or less diffused itself over the minds of Christians in every part of Europe; but no where had this spirit more successfully made its approaches than in Saxony. Intoxicated with the luxury, and dazzled with the magnificence of the Roman court, the Italians satisfied themselves with ridiculing the vices of the church in poems and visions; but took no effectual steps towards bringing about a reformation. They consoled themselves with the reflection, that though their chief city was the seat of vice and debauchery, it was also the residence of the supreme head of the church, the great depository of riches, the scene of pomp and grandeur, and the nursery of the fine arts. The magnificence of ancient ruins, the number of religious edifices, and the splendour of crowded processions, gave a sort of dignity and importance to the city of the Cæsars, and superseded pure devotion and simple prayers; while a religion which captivated the senses of the Italians, lulled their vices, and caused them to think reformation less needful than it was. In Saxony, however, the case was different. This hardy race of men had never been corrupted by luxury. Almost the last to embrace the doctrines of the Christian faith, when they were compelled by Charlemagne to become Christians, they soon embraced the gospel with sincerity and simplicity. They had, with the profession of popery, preserved their principles in a great degree free from the evils with which that system of religion had been attended in other countries. They were papists; but popery was not the whole of their religion; when, therefore, the corruptions of the church were brought before their view, they first despised, then abhorred, and at last forsook them. They had always been impatient under the Roman yoke, and were fully ripe for a reformation which promised them freedom of thought and the full exercise of natural liberty. The revival of literature, which manifested itself in Italy by the fine arts, the enjoyments of taste, and the classical beauties of ancient Greece and Rome, operated on the minds of the sober and active Saxons in the cultivation of metaphysics, philosophy, and history. When, therefore, the reformation broke forth, the Saxon theologians were more than a match for the Italian poets, painters, and Platonists. Ariosto and Luther were very different characters: To the one the world is indebted for a diffusion of the true spirit of poetry; to the other, that of piety, and the right of private judgment in matters of faith and worship. It was reserved for the bold and enterprising genius of Luther to unloose the trammels by which the minds of men had been so long fettered; to open the prison doors to those that were bound; to silence by scripture and argument the thunders of the Vatican; and to assure the world, that the human mind is naturally free.

To support the expenses of a luxurious court, Leo X. had availed himself of an ancient custom in the church to raise money by the sale of indulgences, by which the purchasers were allowed the practice of several sins, and a deliverance from the pains of purgatory. To defend these indulgences, it was urged, that as one drop of Christ's blood is sufficient to atone for the sins of the whole world, the remainder of blood shed by the death of the Saviour belonged to the church, and that its efficacy might be sold out to the people. It was supposed also, that to the church belonged all the good works of the saints beyond what were employed in their own justification. These superabundant merits were accordingly sold to the unthinking multitude at various prices, according to the nature of the offence for which they were to atone. The form of these indulgences not being very generally known, we will give an exact copy of one of these most extraordinary instruments.

"May our Lord Jesus Christ have mercy upon thee, and absolve thee by the merits of his most holy passion. And I, by his authority, that of his blessed apostles, Peter

and Paul, and of the most holy Pope, granted and committed to me in these parts, do absolve thee, first from all ecclesiastical censures, in whatever manner they have been incurred; and then, from all thy sins, transgressions, and excesses, how enormous soever they maybe, even from such as are reserved for the cognizance of the holy see; and as far as the keys of the holy church extend, I remit you all punishment you deserve in purgatory on their account; and I restore you to the holy sacraments of the church, to the unity of the faithful, and to that innocence and purity you possessed at baptism; so that when you die, the gates of punishment shall be shut, and the gates of the paradise of life shall be opened; and if you shall not die at present, this grace shall remain in full force when you are at the point of death. In the name of the Father, of the Son, and of the Holy Ghost. Amen."

This is the form of absolution sold by the agents of Leo X. in various parts of the Christian world; an instrument so absurd, that were it not well authenticated, and had we not even in our day a similar instance of imposture on the one hand and credulity on the other, in the seals disposed of by Johanna Southcott, one might be tempted to doubt the truth of its existence.

The promulgation of these indulgences in Germany, together with a share arising from the profits in the sale of them, was assigned to Albert, Elector of Mentz, and Archbishop of Magdeburg, who, as his chief agent for retailing them, employed one Tetzel, a Dominican Friar of licentious morals, but of a bold and active spirit. Tetzel, assisted by the monks of his order, executed this ignoble commission with great zeal and success: but with the most shameless indecency and indiscretion; at the same time magnifying the benefits of these indulgences in the most extravagant manner. To such enormities did Tetzel proceed in describing the efficacy of these pretended dispensations, that he even said "if any one had ravished the mother of God, he (Tetzel) had wherewithal to efface his guilt." He also boasted, that "he had saved more souls from hell by these indulgences, than St. Peter had converted to Christianity by his preaching." These enormous blasphemies and abuses roused the indignation of Martin Luther, a monk of the Augustinian Eremites, and professor of divinity in the academy at Wittemberg, to such a pitch of fervour, that he began to declaim with boldness against these scandals of the Christian name. In ninety-five propositions, maintained publicly at Wittemberg, on the 30th of September 1517, he censured the extravagant extortions, of the questors, and plainly pointed out the Roman Pontiff as a partaker of their guilt, since he suffered the people to be seduced, by such delusions, from placing their principal confidence in Christ, the only proper object of their trust. So daring an opposition from an obscure monk in a corner of Germany, excited the surprise and admiration of all the world, except Rome itself, which seemed most likely to have been first alarmed. Luther had no sooner published his propositions than multitudes flocked to his standard, and joined him in the outcry against the shameful abominations of the Church of Rome. It was, however, some time before an irruption took place; or that the friends of reform declared open war against the decrees and authority of the Church. Tetzel and others vainly attempted to defend the indulgences; but were continually repulsed, and put to shame by the arguments and intrepidity of Luther. The history of the various disputes which called forth the energies of this Reformer, and exposed the nakedness of the Church, is both interesting and curious: we must nevertheless pass over this portion of the history of the reformation in Germany; observing that Luther and his adherents soon found most powerful auxiliaries in the University of Wittemberg, and the protection of Frederick, Elector of Saxony.

While the Saxon reformer was daily making inroads on the authority of the Roman See, first by an opposition to the promulgation of indulgences, and from that, by a fearless exposure of the errors and doctrines of the Catholic Church itself, the Pope and Cardinals at Rome were asleep in the arms of luxury, and insensible of their danger amidst the enjoyments of polite literature, the mysticisms of Plato, the glare of outward grandeur, and the stupefactions of sensuality. It is true, the supineness of Leo was often reproved by those who had the interests of the Church at heart; but the natural benevolence of that pontiff's disposition, and his utter aversion to business, or solicitude, rendered it difficult to convince him that the disputes in Saxony were any thing besides the squabbles of restless and ignorant monks, unworthy his regard, and beneath his interference. And when at length he was reminded by the Emperor

Maximilian, that his forbearance or negligence began to be dangerous, the matter had gone too far to be easily arrested.

Emboldened by success, encouraged by the increasing number of his adherents, and above all, protected by the secular power, Luther had already proceeded much farther in the work of reformation, than it is probable he himself at first intended; when therefore he was summoned by the Pope to appear before him at Rome, by the interference of Frederick the Wise, he procured the liberty of being heard in a conference to be held in Germany. This indulgence might possibly have somewhat abated the zeal and opposition of Luther, had proper persons been chosen to give him a hearing. But, instead of this, the persons appointed to this service were his avowed enemies, the Bishop of Ascula, and Silvestero Prierio. Poor and bare-footed, Luther, having commended himself and his cause to God, boldly repaired to Augsburg, after having written to his friend and fellow reformer, Philip Melancthon, to the following effect: "I know nothing new or extraordinary here, except that I am become the subject of conversation throughout the whole city, and that every one wishes to see the man who is to be the victim of such a conflagration. You will act your part properly, as you have always done; and teach the youth intrusted to your care. I go, for you, and for them, to be sacrificed if it should so please God. I rather choose to perish, and what is more afflicting, to be for ever deprived even of your society, than to retract what I have already asserted, or to be the means of affording the stupid adversaries of all liberal studies an opportunity of accomplishing their purpose."

With such sentiments and resolutions this fearless reformer proceeded to defend himself and his doctrines against the sense and authority of the Pope's legate, and any whom that Cardinal might be pleased to appoint for the purpose of opposing the reformation.

At this memorable conference every thing that remonstrance, persuasion, and condescension on the part of the Cardinal of Gaeta could effect, were used, to bring back this unruly reformer to an implicit obedience to the authority and practices of the holy see; but all in vain. Luther gained additional strength and boldness by every encounter; and the conference closed with an appeal to Leo the Tenth, in which, after recapitulating the proceedings which had already taken place, Luther decla[res] that he is not conscious of having [ad]vanced any thing against the holy scr[ip]tures, the ecclesiastical fathers, the [de]crees of the popes, or right reason; [but] that all which he has said is catholic, pr[o]per, and true. Being however a man, a[nd] therefore liable to error, he submits him[self] to the church, and offers himself personall[y] either there or elsewhere, to adduce t[he] reasons of his belief, and reply to all obje[c]tions that may be made against it. Th[is] protest not satisfying the mind of the Card[i]nal, through the interference of some [of] Luther's friends, he procured from the re[]former a conciliatory letter, in which h[e] acknowledges that he has been indiscree[t] in speaking in disrespectful terms of the su[]preme pontiffs; and promises even to be si[]lent in future respecting indulgences, provided his adversaries were also compelled to be silent, or were restrained in their abuse of him. With these concessions, and an appeal from Leo the Tenth, prejudiced and misled, to Leo the Tenth, better informed on the subject, Luther abruptly quitted the city of Augsburg. Notwithstanding this disrespectful conduct, the Cardinal did not avail himself of the powers with which he had been entrusted, to excommunicate Luther and his adherents; but appealed to the Elector of Saxony, and requested, that if Luther still persisted in his opposition to the church, he might be either sent to Rome, or, at least, banished from his dominions. The Elector refused to comply with either of these requests; and the work of reformation was suffered to go on.

As it was impossible that the vicar of Christ should enter into a formal dispute with the monk of Wittemberg, nothing now remained, but either to adopt the decisive measure of excommunicating the unbending reformer, or to put his professions of obedience to the test, by a formal decree against his doctrines, and by a papal bull, expressly declaring, that as the Pope is the successor of St. Peter, and vicar of Christ upon earth, he hath an undoubted power of granting indulgences, which avail as well the living as the dead in purgatory; and that this doctrine is essential to the salvation of every true and obedient son of the church. Accordingly, a bull, to this purport, was signed on the 7th day of November, 1518, and published throughout the christian world. This put the sincerity and boldness of Luther to the test, who soon decided concerning the measures he should

adopt, either of instant and unqualified submission, or open contumacy. Luther determined upon the latter, and commenced hostilities against the infallibility of the Pope, by an appeal from the authority of the supreme head to a general council. Here then commenced that schism which caused even the vicar of Christ to tremble, and which laid a train under the foundations of spiritual domination and superstition that must one day not only agitate and deform the superstructure, as it already has done, but finally destroy the whole fabric, and leave not one stone upon another that shall not be thrown down.

Nothing now could have prevented the immediate destruction of Luther and his adherents, had not the attention of Europe been drawn aside from theological disputes to subjects of political discussion and debate. Luther was therefore suffered, without any great interference, to proceed in the work in which he had engaged. By voluntarily offering to submit his opinions to the decisions of reason and revelation, and by making common cause with the friends of freedom and literature, his success exceeded even the most sanguine expectations of his warmest friends. In what manner Luther conducted himself after he had succeeded in establishing a new system of religious faith and discipline, and what were the peculiarities of his creed, the reader will have observed in the articles LUTHERANS, and PROTESTANTS. See also ROMAN CATHOLICS.

From Germany, by the writings of Luther, and from Switzerland, by the zeal and perseverance of Zuinglius, the work of reform proceeded to spread itself over Denmark, Sweden, Geneva, Holland, England, and Scotland. In France, Spain, and Italy, the reformation made comparatively but little progress. The same also is to be observed of Poland and Russia. The names of the principal reformers are the following; and we are induced to enumerate them, that by consulting the various biographical accounts that have, from time to time, been published of them, our readers may enter more minutely into this very important branch of modern history:

Luther, Erasmus, and Melancthon; Calvin, Zuinglius, and Oecolampadius; Bullinger, Beza, and Martyr. In England, Henry VIII. Edward VI. Ridley, Latimer, Hooper, Cranmer, and Queen Elizabeth. In Scotland, the reformation was forwarded by the zeal and industry of Knox. These are the names of some of those men to whom the religious world is at this time indebted for that freedom of thought, and many of those Christian privileges, with which it is so eminently favoured.

That in every instance the motives of the reformers were pure, we do not contend; nor are we disposed to conceal the fact, that many of them possessed a spirit of intolerance inconsistent with the principles of entire liberty. The priestly audacity of Luther, the time-serving policy of the learned Erasmus, the censurable timidity of Melancthon, and, above all, the fiery spirit and persecuting zeal of Calvin, which condemned to the flames one of the best men of his age, M. Servetus, who had presumed to express his doubts concerning the Trinity, are so many blots in the history of the reformation which Christians of our own time would do well carefully to avoid. For a brief, but elegant, account of the causes and progress of the reformation by Luther, the reader may consult the invaluable work of Mr. Roscoe, entitled The Life and Pontificate of Leo the Tenth; vols. iii. and iv. He should also peruse Burnet's History of the Reformation; and Dr. Robertson's History of Charles the Fifth.

REFRACTION, in astronomy, or REFRACTION *of the stars*, is an inflexion of the rays of those luminaries, in passing through our atmosphere, by which the apparent altitudes of the heavenly bodies are increased. This refraction arises from hence, that the atmosphere is unequally dense in different stages or regions; rarest of all at the top, and densest of all at the bottom; which inequality, in the same medium, makes it equivalent to several unequal mediums, by which the course of the ray of light is continually bent into a continued curve line. And Sir Isaac Newton has shown, that a ray of light, in passing from the highest and rarest part of the atmosphere, down to the lowest and densest, undergoes the same quantity of refraction that it would do in passing immediately, at the same obliquity, out of a vacuum into air of equal density with that in the lowest part of the atmosphere.

Hence arise the phenomena of the crepusculum or twilight; and hence also it is, that the moon is sometimes seen eclipsed, when she is really below the horizon, and the sun above it.

That there is a real refraction of the stars, &c. is deduced not only from physical considerations, and from arguments

a priori, but also from precise astronomical observations: for there are numberless observations, by which it appears that the sun, moon, and stars rise much sooner, and appear higher, than they should do according to astronomical calculations. Hence it is argued, that as light is propagated in right lines, no rays could reach the eye from a luminary below the horizon, unless they were deflected out of their course, at their entrance into the atmosphere; and therefore it appears that the rays are refracted in passing through the atmosphere. Since the stars appear higher by refraction than they really are; to bring the observed or apparent altitudes to the true ones, the quantity of refraction must be subtracted. Accordingly the ancients, as they were not acquainted with this refraction, reckoned their altitudes too great. Refraction lengthens the day, and shortens the night, by making the sun appear above the horizon a little before his rising, and a little after his setting. Refraction also makes the moon and stars appear to rise sooner, and set later, than they really do. The apparent diameter of the sun or moon is about 32′; the horizontal refraction is about 33′; whence the sun and moon appear wholly above the horizon when they are entirely below it. Also, from observations it appears that the refractions are greater nearer the pole than at lesser latitudes, causing the sun to appear some days above the horizon, when he is really below it; doubtless from the greater density of the atmosphere, and the greater obliquity of the incidence.

Stars in the zenith are not subject to any refraction: those in the horizon have the greatest of all: from the horizon the refraction continually decreases to the zenith. All which follows from hence, that in the first case, the rays are perpendicular to the medium; in the second, their obliquity is the greatest, and they pass through the largest space of the lower and denser part of the air, and through the thickest vapours; and in the third, the obliquity is continually decreasing. The air is condensed, and consequently refraction is increased, by cold; for which reason it is greater in cold countries than in hot ones. It is also greater in cold weather than in hot, in the same country; and the morning refraction is greater than that of the evening, because the air is rarified by the heat of the sun in the day, and condensed by the coldness of the night. Refraction is also subject to some small variation at the same time of the day in the finest weather.

The horizontal refraction, being the greatest, is the cause that the sun and moon appear of an oval form at their rising and setting; for the lower edge of each being more refracted than the upper edge, the perpendicular diameter is shortened, and the under edge appears more flatted also. Again, if we take with an instrument the distance of two stars when they are in the same vertical and near the horizon, we shall find it considerably less than if we measure it when they are both at such a height as to suffer little or no refraction; because the lower star is more elevated than the higher. There is also another alteration made by refraction in the apparent distance of stars: when two stars are in the same parallel of declination, their apparent distance is less than the true; for since refraction makes each of them lighter in the azimuth or vertical in which they appear, it must bring them into parts of the vertical where they come nearer to each other; because all vertical circles converge and meet in the zenith. This contraction of distance, according to Dr. Halley, (Philos. Trans. numb. 368) is at the rate of at least one second in a degree; so that, *if the distance* between two stars in a position parallel to the horizon, measure 30°, it is at most to be reckoned only 29°, 59′, 30″.

The quantity of the refraction at every altitude, from the horizon, where it is greatest, to the zenith where it is nothing, has been determined by observation, by many astronomers; those of Dr. Bradley and Mr. Mayer are esteemed the most correct of any, being nearly alike, and are now chiefly used by astronomers. Dr. Bradley, from his observations, deduced this general rule for the refraction, r, at any altitude, a, whatever; *viz.* as rad. 1 : cotang. $\overline{a+3r}$ :: 57″ : r'' the refraction in seconds. This rule is adapted to these states of the barometer and thermometer, *viz.* either 29.6 inch barometer and 50° thermometer, or 30 inch barometer and 55° thermometer, for both which states it answers equally the same. But for any other states of the barometer and thermometer, the refraction above found is to be corrected in this manner; *viz.* if b denote any other height of the barometer in inches, and t the degrees of the thermometer, r being the refraction incorrected, as found in the manner above. Then as 29.6 : b :: r : R the refraction corrected

on account of the barometer, and 400 : 450 t : : R the refraction corrected both on account of the barometer and thermometer; which final corrected refraction is therefore $= \frac{450 - t}{11840}\, br$. Or, to correct the same refraction, r, by means of the latter state, *viz.* barometer 30 and thermometer 55, it will be as $30 : b :: r : R = \frac{br}{30}$, and $400 : 455 - t :: R : \frac{455 - t}{400} R = \frac{455 - t}{12000}$ br the correct refraction.

Mr. Simpson has determined, by theory, the astronomical refractions, from which he brings out this rule, *viz.* as 1 to .9986 or as radius to sine of 86° 58′ 30″, so is the sine of any given zenith distance, to the sine of an arc; then $\frac{1}{11}$ of the difference between this arc and the zenith distance, is the refraction sought for that zenith distance. And by this rule Mr. Simpson computed a table of the mean refractions, which are not much different from those of Dr. Bradley and Mr. Mayer, and are as in the following table. See Simpson's Dissertations.

MR. SIMPSON'S TABLE OF MEAN REFRACTIONS.

Apparent Altitude.	Refraction.		Apparent Altitude.	Refraction.		Apparent Altitude.	Refraction.	
0°	33′	0″	17°	2′	50″	38°	1′	7″
1	23	50	18	2	40	40	1	2
2	17	43	19	2	31	42	0	58
3	13	44	20	2	23	44	0	54
4	11	5	21	2	16	46	0	50
5	9	10	22	2	9	48	0	47
6	7	49	23	2	3	50	0	44
7	6	48	24	1	57	52	0	41
8	5	59	25	1	52	54	0	38
9	5	21	26	1	47	56	0	35
10	4	50	27	1	42	58	0	32
11	4	24	28	1	38	60	0	30
12	4	2	29	1	34	65	0	24
13	3	43	30	1	30	70	0	19
14	3	27	32	1	23	75	0	14
15	3	13	34	1	17	80	0	9
16	3	1	36	1	12	85	0	4½

It is evident that all observed altitudes of the heavenly bodies ought to be diminished by the numbers taken out of the foregoing table. It is also evident that the refraction diminishes the right and oblique ascensions of a star, and increases the descensions; it increases the northern declination and latitude, but decreases the southern; in the eastern part of the heavens it diminishes the longitude of a star, but in the western parts of the heavens it increases the same. See QUADRANT.

REFRACTION, *terrestrial*, is that by which terrestrial objects appear to be raised higher than they really are, in observing their altitudes. The quantity of this refraction is estimated by Dr. Maskelyne at one-tenth of the distance of the object observed, expressed in degrees of a great circle. So, if the distance be 10,000 fathoms, its tenth part 1000 fathoms, is the sixtieth part of a degree of a great circle on the earth, or 1″ which therefore is the refraction in the altitude of the object at that distance. But M. Le Gendre is induced, he says, by several experiments, to allow only one-fourteenth part of the distance for the refraction in altitude. So that, upon the distance of 10,000 fathoms, the fourteenth part of which is 714 fathoms, he allows only 44″ of terrestrial refraction, so many being contained in the 714 fathoms. See his Memoir concerning the trigonometrical operations, &c. Again, M. de Lambre, an ingenious French astronomer, makes the quantity of the terrestrial refraction to be the eleventh part of the arch of distance. But the English measurers, Col. Edward Williams, Capt. Mudge, and Mr. Dalby, from a multitude of exact observations made by them, determine the quantity of the medium refraction to be the twelfth part of the said distance. The quantity of this refraction, however, is found to vary considerably, with the different states of the weather and atmosphere, from the fifteenth part of the distance to the ninth part of the same, the medium of which is the twelfth part, as above mentioned. Some whimsical effects of this refraction are also related, arising from peculiar situations and circumstances. Thus, it is said, any person standing by the side of the river Thames, at Greenwich, when it is high water there, he can see the cattle grazing on the Isle of Dogs, which is the marshy meadow on the other side of the river at that place; but when it is low water there, he cannot see any thing of them, as they are hid from his view by the land wall or bank on the other side, which is raised higher than the marsh, to keep out the waters of the river. This curious effect is probably owing to the moist and dense vapours, just above and rising from the surface of the water, being raised higher or lifted up with the surface of the water at the time of high tide, through which the rays pass, and are the more refracted.

Refraction, in general, is the deviation of a moving body from its direct course, occasioned by the different density of the medium it moves in; or it is a change of direction, occasioned by a body's falling obliquely out of one medium into another of a different density. The great law of refraction, which holds in all bodies, and all mediums, is, that a body, passing obliquely out of one medium into another wherein it meets with less resistance, is refracted or turned towards the perpendicular; and, on the contrary, in passing out of one medium into another wherein the resistance is greater, it is refracted or turned from the perpendicular. Hence the rays of light, falling out of air into water, are refracted towards the perpendicular; whereas a ball thrown into the water, is refracted from it. Now the reason of this difference is, that water, which resists the motion of light less than air, resists that of the ball more; or, to speak more justly, because water, by its greater attraction, accelerates the motion of the rays of light more than air does. See Optics.

Refraction *in island crystal*. There is a double refraction in this substance, contrary ways, whereby not only oblique rays are divided into two, and refracted into opposite parts, but even perpendicular rays, and one half of them refracted.

REGALIA, in law, the royal rights of a King, which, according to civilians, are six: power of judicature; power of life and death; power of war and peace; goods without owner, as waifs, strays, &c.; assessments; and minting of money.

REGIMEN, in grammar, that part of syntax, or construction, which regulates the dependency of words, and the alterations which one occasions in another.

REGIMENT, in war, is a body of men, either horse or foot, commanded by a colonel. Each regiment of foot is divided into companies, but the number of companies is not always alike, though our regiments generally consist of ten companies, one on the right of grenadiers, and another on the left of light troops. Regiments of horse most commonly consist of six troops, but some have nine. Regiments of dragoons, in time of war, are generally composed of eight troops, and in time of peace, of six. Each regiment has a chaplain and a surgeon. See Troop and Company. Some German regiments consist of 2000 foot, and the regiment of Picardy, in the old French service, consisted of 120 companies, or 6000 men.

REGISTER, a public book, in which is entered and recorded memoirs, acts, and minutes to be had recourse to occasionally for knowing and proving matters of fact. Of these there are several kinds; as, 1. Registers of deeds in Yorkshire and Middlesex, in which are registered all deeds, conveyances, wills, &c. that affect any lands or tenements in those counties, which are otherwise void against any subsequent purchasers, or mortgagees, &c.; but this does not extend to any copyhold estate, nor to leases at a rack rent, or where they do not exceed twenty-one years. The registered memorials must be engrossed on parchment, under the hand and seal of some of the grantors or grantees, attested by witnesses who are to prove the signing or sealing of them, and the execution of the deed. But these registers, which are confined to two counties, are in Scotland general, by which the laws of North Britain are rendered very easy and regular. Of these there are two kinds: the one general, fixed at Edinburgh, under the direction of the Lord Register; and the other is kept in the several shires, stewartries, and regalities, the clerks of which are obliged to transmit the registers of their respective courts to the general register. No man in Scotland can have a right to any estate, but it must become registered within forty days of his becoming seised thereof; by which means all secret conveyances are cut off. 2. Parish registers are books in which are registered the baptisms, marriages, and burials of each parish.

Among dissenters who admit of infant baptism, each minister is supposed to keep a register of the several children baptized by him. But as these are frequently lost, by the succession of new ministers to the same congregation; or at best do not give an account of the date of the births, which may have happened many weeks or months before baptism, it is now almost generally the custom among dissenters of all denominations to register the births of their children at the Library in Red-cross Street, Cripplegate, for which the charge is sixpence. This register is admitted in the courts of law.

Register, is also used for the clerk or keeper of a register. Of these we have several, denominated from the registers they keep; as Register of the High Court of Delegates; Register of the Arches Court of Canterbury; Register of the Court of Admiralty; Register of the Prerogative Court; Register of the Garter, &c.

Register *ships*, in commerce, are vessels which obtain a permission either from the King of Spain, or the Council of the Indies, to traffic in the ports of the Spanish West Indies; which are thus called from their being registered before they set sail from Cadiz, for Buenos Ayres. Each of these permissions costs 30,000 pieces of eight, and by the tenor of the cedula, or permit, they are not to exceed 300 tons; but there is such a good understanding between the merchants, and the Council of the Indies, that ships of 5 or 600 tons frequently pass unnoted; and though the quantity and quality of the merchandizes on board are always expressed, yet, by means of presents, the officers, both in Spain and the Indies, allow them to load and unload vastly more than the permission expresses.

Register, in printing, is disposing the forms on the press, so as that the lines and pages printed on one side of the sheet fall exactly on those of the other.

Register, among letter founders, is one of the inner parts of the mould in which the printing types are cast. Its use is to direct the joining the mould justly together again, after opening it to take out the new cast letter.

Registers, in chemistry, are holes, or chinks with stopples, contrived in the sides of furnaces, to regulate the fire; that is, to make the heat more intense, or remiss, by opening them to let in the air, or keeping them close to exclude it.

REGULAR, denotes any thing that is agreeable to the rules of art: thus, we say a regular building, verb, &c. A regular figure, in geometry, is one whose sides, and consequently angles, are equal; and a regular figure with three or four sides is commonly termed an equilateral triangle, or square, as all others with more sides are called regular polygons. All regular figures may be inscribed in a circle. A regular solid, called also a platonic body, is that terminated on all sides by regular and equal planes, and whose solid angles are all equal. See Body.

REGULUS, in chemistry, an imperfect metallic substance, that falls to the bottom of the crucible, in the melting of ores, or impure metallic substances.

Regulus, in astronomy, a star of the first magnitude, in the constellation Leo, called also, from its situation, *Cor Leonis*, or the lion's heart. Its longitude, according to Mr. Flamsteed, is 25° 31′ 20″, and its latitude 0° 26′ 38″ north.

REHEARING, in chancery, is when either of the parties thinks himself aggrieved by a decree, and petitions the Chancellor for the cause to be heard again.

REIN *deer*. See Cervus.

REJOINDER, in law, is the name of a part of the pleadings where the defendant answers to the plaintiff's replication.

RELEASE, in law. Releases are distinguished into express releases in deed, and those arising by operation of law; and are made of lands and tenements, goods and chattels, or of actions real, personal, and mixed. By a release of all demands, all actions real, personal, and mixed, and all actions of appeal, are extinct. The release of a right to lands is now become the most usual form of conveyance. A lease is made for a year, which puts the party in possession, and then a release of all the right to the lessee and his heirs is made the next day; which, by the operation of the statute of uses, conveys the whole fee. This is called a conveyance by lease and release.

RELHANIA, in botany, so named in honour of the Rev. Richard Relhan, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Essential character: calyx imbricate, scariose; corollets of the ray very many; pappus membranaceous, cylindrical, short; receptacle chaffy. There are sixteen species, all natives of the Cape of Good Hope.

RELIEF, a certain sum of money which the tenant holding by knight's service, grand serjeantry, or other tenure, for which homage or legal service is due, and being at full age at the death of his ancestor, formerly paid to his lord at his entrance.

RELIEVO, or Relief, in sculpture, &c. is the projecture or standing out of a figure, which arises prominent from the ground or plan on which it is formed; whether that figure be cut with the chissel, moulded, or cast.

There are three kinds or degrees of relievo, viz. alto, basso, and demi-relievo. The alto-relievo, called also haut-relief, or high relievo, is when the figure is formed after nature, and projects as much as the life. Basso-relievo, bass-relief, or low-relievo, is when the work is raised but a little from the ground, as in medals, and the frontispieces of buildings; and particularly in the histories, festoons, foliages, and other ornaments of friezes. Demi-relievo is when one half of the figure rises from the plan. When, in a basso-relievo, there are parts that stand

clear out, detached from the rest, the work is called a demi-basso. In architecture, the relievo or projecture of the ornaments, ought always to be proportioned to the magnitude of the building it adorns, and to the distance at which it is to be viewed.

Relievo, or Relief, in painting, is the degree of boldness with which the figures seem, at a due distance, to stand out from the ground of the painting. The relievo depends much upon the depth of the shadow, and the strength of the light; or on the height of the different colours, bordering on one another; and particularly on the difference of the colour of the figure from that of the ground. Thus, when the light is so disposed as to make the nearest parts of the figure advance, and is well diffused on the masses, yet insensibly diminishing, and terminating in a large spacious shadow, brought off insensibly, the relievo is said to be bold, and the clair-obscure well understood.

RELIGION, seditious words, in derogation of the established religion, are indictable, as tending to a breach of the peace.

REMAINDER, in law, is an estate limited in lands, tenements, or rents, to be enjoyed after the expiration of another particular estate. As if a man seised in fee-simple grant lands to one for twenty years, and, after the determination of the said term, then to another, and his heirs for ever; here the former is tenant for years, remainder to the latter in fee. Both interests are, in fact, only one estate; the present term of years, and the remainder afterwards, when added together, being equal only to one estate in fee. When a remainder is limited in a will, it is sometimes called an executory devise. This is not strictly a remainder, but something in nature of a remainder, which, though informal and bad, as such, is held good as an executory devise. The doctrine of remainders is very abstruse, chiefly from the difficulty of ascertaining from the form of the deed or will by which it is created, whether or not the remainder is contingent, and liable to be defeated. Where a remainder is limited after an estate tail, the tenant in tail can at all times, by suffering a recovery, defeat the remainder, and get possession of the fee. This is called docking the entail, and it is allowed for the purpose of preventing limitations in perpetuity. For, otherwise, men of large landed estates would be enabled to tie up the inheritance so strictly by will, that in a few years all the landed property in the kingdom would be vested for ever in certain families, and that circulation of wealth, which is the great spur to industry, would be wholly at an end. Hence would be introduced all the inconvenience of a system of casts similar to those in the East Indies, and in a short time there would be no change in the course of inheritances, except upon forfeitures for felony, or high treason, which would rarely occur. Or, perhaps, the consequence would be, that the inheritance of females not being forbidden, the land would be so subdivided by different descents to coheiresses, that there would be no large estates in the country. This sufficiently evinces the wisdom of the law, which prevents bequests in perpetuity, and we have thought it better to notice this in a popular work, than to explain at length a term of art which unavoidably leads to the most abstruse reasoning. For further information, see Jacob's Law Dict. by Tomlins, title Remainder; Fearne's Essay on Remainders, and other works there cited.

REMEMBRANCERS, anciently called clerks of the remembrance, certain officers in the Exchequer, whereof three are distinguished by the names of the King's Remembrancer, the Lord Treasurer's Remembrancer, and the Remembrancer of the First Fruits. The King's Remembrancer enters in his office all recognizances taken before the Barons, for any of the King's debts, for appearances or observances of orders; he also takes all bonds for the King's debts, &c. and makes out processes thereon. He likewise issues processes against the collectors of the customs, excise, and others, for their accounts; and informations upon penal statutes are entered and sued in his office, where all proceedings in matters upon English bills in the Exchequer Chamber remain. His duty further is to make out the bills of compositions upon penal laws, to take the statement of debts; and into his office are delivered all kinds of indentures and other evidences, which concern the assuring any lands to the crown. He, every year, in *crastino animarum*, reads in open court the statute for election of sheriffs; and likewise openly reads, in court, the oaths of all the officers, when they are admitted.

The Lord Treasurer's Remembrancer is charged to make out process against all sheriffs, escheators, receivers, and bailiffs, for their accounts. He also makes out writs

of fieri facias, and extent for debts due to the King, either in the pipe or with the auditors; and process for all such revenue as is due to the King, on account of his tenures. He takes the account of sheriffs; and also keeps a record, by which it appears whether the sheriffs or other accountants pay their profers due at Easter and Michaelmas: and at the same time he makes a record, whereby the sheriffs or other accountants keep their prefixed days. There are likewise brought into his office all the accounts of customers, comptrollers, and accountants, in order to make entry thereof on record: also all estreats and amercements are certified here, &c.

The Remembrancer of the First Fruits takes all compositions and bonds for the payment of first fruits and tenths, and makes out process against such as do not pay the same.

REMITTER, a term in law, which implies that a person having a right is dispossessed, and then by a bad title, different from his former one, gets possession. He is then said to be remitted to his former title, or to be in by remitter, and cannot be turned out, although he gained his last possession by a bad title.

RENDEZVOUS, in a military sense, the place appointed by the general, where all the troops that compose the army are to meet at the time appointed, in case of an alarm. This place should be fixed upon according to the situation of the ground and the sort of troops quartered in the village. In an open country it is easy to fix upon a place of rendezvous, because the general has whatever ground he thinks necessary. In towns and villages the largest streets, or market-places, are very fit; but let the place be where it will, the troops must assemble with ease, and be ready for the prompt execution of orders.

RENEALMIA, in botany, so named from Paul Reneaume, physician at Blois, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: calyx trifid; nectary oblong; calyx one-leafed, bursting into two or three irregular teeth; anther sessile, opposite to the nectary; berry fleshy. There is but one species, viz. R. exaltata, a tree about twenty feet in height, having a straight trunk; leaves five or six feet long, lanceolate, waved about the edge; the raceme or bunch of flowers springs from the trunk above the root. It is a native of Surinam.

RENT, is a certain profit issuing yearly out of lands and tenements corporeal. There are at common law three kinds of rents; rent service, rent charge, and rent seck. Rent service is where the tenant holds his land of his lord by fealty and certain rent; or by homage, fealty, and certain rent; or by other service and certain rent; and it is called a rent service, because it has some corporal service incident to it, which at least is fealty. Rent charge is so called because the land for payment thereof is charged with a distress. Rent seck is where the land is granted without any clause of distress for the same.

The time for payment of rent, and, consequently, for a demand, is such a convenient time before the sun-setting of the last day, as will be sufficient to have the money counted; but if the tenant meet the lessor on the land at any time of the last day of payment, and tender the rent, that is sufficient tender, because the money is to be paid indefinitely on that day, and therefore a tender on that day is sufficient. The remedy for non-payment of rent is by distress, or taking the goods and chattels, or by action of debt. See Woodfall's Landlord and Tenant, or Tomlins's Law Dictionary.

REPELLING *power*. See REPULSION.

REPETEND, in arithmetic, denotes that part of an infinite decimal fraction which is continually repeated ad infinitum. Repetends chiefly arise in the reduction of vulgar fractions to decimals: thus $\frac{1}{3} = 0.333$, &c. A single repetend is that in which only one figure is repeated, as in the instance just given. A compound repetend is that in which two or more figures are repeated. "To find the value of any repetend, or to reduce it to a vulgar fraction." Rule. Take the given repeating figure or figures for the numerator, and for the denominator, take as many 9's as there are recurring figures or places in the given repetend: thus, $3 = \frac{3}{9} = \frac{1}{3}$ and $123 = \frac{123}{999} = \frac{41}{333}$.

REPETITION, in rhetoric, a figure which gracefully and emphatically repeats either the same word, or the same sense in different words. In the use of this figure care is to be used that we run not into insipid tautologies, nor affect a trifling sound and chime of insignificant words. All turns and repetitions are so that do not contribute to the strength and lustre of the

discourse, or at least one of them. The nature and design of this figure is to make deep impressions on those we address. It expresses anger and indignation, full assurance of what we affirm and a vehement concern for what we have espoused.

REPLEVIN, in law, is a writ by him, who has cattle or other goods distrained by another, for any cause. If he wishes to dispute the propriety of the distress, he sues this writ, and upon putting in surety to the sheriff, that upon delivery of the thing distrained, he will prosecute the action against the distrainer, the cattle or goods are delivered back, and said to be replevied. In this writ, or action, both the plaintiff and defendant are called actors; the one, that is the plaintiff, suing for damages, and the defendant, who is also called avowant, to have a return of the goods or cattle.

Replevins by writ issue properly out of Chancery, returnable into the courts of King's Bench and Common Pleas at Westminster.

After the goods are delivered back to the party replevying, he is bound to bring his action of replevin against the distrainer; which may be prosecuted in the county court, be the distress of what value it may: but either party may remove it to the superior courts of King's-Bench or Common-Pleas, the plaintiff at pleasure, and the defendant upon reasonable cause.

If the sheriff is shown a stranger's goods, and he takes them, an action of trespass lies against him, for otherwise he could have no remedy; for being a stranger, he cannot have the writ *de proprietate probanda*, and were he not entitled to this remedy, it would be in the power of the sheriff to strip a man's house of all his goods.

If the replevin be determined for the plaintiff, namely, that the distress was wrongfully taken, he has already got his goods back into his own possession, and shall keep them, and recover damages. But if the defendant prevail, by the default or non-suit of the plaintiff, then he shall have a writ *de returno habendo*, or to have a return, whereby the goods or chattels, which were distrained and then replevied, are returned again into his custody, to be sold, or otherwise disposed of, as if no replevin had been made. If the distress were for damage feasant, that is, for cattle breaking through fences, and coming upon the land of the party, the distrainer may keep the goods so returned, until tender shall be made of sufficient amends.

REPLICATION, a law term, signifying a part of the pleadings upon the record, being the plaintiff's answer to the defendant's pleas.

REPRIEVE, an order to suspend a prisoner from the execution and proceeding of the law for a time. Every judge, who has power to order any execution, has power to reprieve.

REPRISE, or REPRIZE, at sea, is a merchant ship which, after its being taken by a corsair, privateer, or other enemy, is retaken by the opposite party. If a vessel thus retaken has been twenty-four hours in the possession of the enemy, it is deemed a lawful prize; but if it be retaken within that time, it is to be restored to the proprietor, with every thing therein, upon his allowing one-third to the vessel who made the reprise. Also if the reprise has been abandoned by the enemy, either in a tempest or from any other cause, before it has been led into any port, it is to be restored to the proprietor.

REPRODUCTION is usually understood to mean the restoration of a thing before existing, and since destroyed. It is very well known that trees and plants may be raised from slips and cuttings; and some late observations have shown, that there are some animals which have the same property. The polype (See HYDRA) was the first instance we had of this kind; but we had scarcely time to wonder at the discovery M. Trembley had made, when M. Bonett discovered the same property in a species of water-worm. Amongst the plants which may be raised from cuttings, there are some which seem to possess this quality in so eminent a degree, that the smallest portion of them will become a complete tree again. A twig of willow, poplar, or many other trees, being planted in the earth, takes root, and becomes a tree, every piece of which will in the same manner produce other trees. The case is the same with these worms; they are cut to pieces, and these several pieces become perfect animals; and each of these may be again cut into a number of pieces, each of which will in the same manner produce an animal. It has been supposed by some that these worms were oviparous; but M. Bonett, on cutting one of them to pieces, having observed a slender substance, resembling a small filament, to move at the end of one of the pieces, separated it; and on examining it with glasses, found it to be a perfect worm, of the same form with its parent

which lived and grew larger in a vessel of water into which he put it. These small bodies are easily divided, and very readily complete themselves again, a day usually serving for the production of a head to the part that wants one; and, in general, the smaller and more slender the worms are, the sooner they complete themselves after this operation. When the bodies of the large worms are examined by the microscope, it is very easy to see the appearance of the young worms alive, and moving about within them; but it requires great precision and exactness to be certain of this; since the ramifications of the great artery have very much the appearance of young worms, and they are kept in a sort of continual motion by the systoles and diastoles of the several portions of the artery, which serve as so many hearts. It is very certain, that what we force in regard to these animals, by our operations, is done also naturally every day in the brooks and ditches where they live. A curious observer will find in these places many of them without heads or tails, and some without either; as also, other fragments of various kinds, all which are then in the act of completing themselves; but whether accidents have reduced them to this state, or they thus purposely throw off parts of their own body for the reproduction of more animals, it is not easy to determine. They are plainly liable to many accidents, by which they lose the several parts of their body, and must perish very early if they had not a power of reproducing what was lost; they often are broken into two pieces, by the resistance of some hard piece of mud which they enter; and they are subject to a disease, a kind of gangrene, rotting off the several parts of their bodies, and must inevitably perish by it, had they not this surprising property.

The reproduction of several parts of lobsters, crabs, &c. is one of the greatest curiosities in natural history. It seems, indeed, inconsistent with the modern system of generation, which supposes the animal to be wholly formed in the egg; that, in lieu of an organical part of an animal cut off, another should arise perfectly like it: the fact, however, is too well attested to be denied. The legs of lobsters, &c. consist each of five articulations; now when any of the legs happen to break by any accident, as by walking, &c. which frequently happens, the fracture is always found to be at the suture near the fourth articulation; and what they thus lose is exactly reproduced in some time afterwards; that is, a part of the leg shoots out, consisting of four articulations, the first whereof has two claws, as before; so that the loss is entirely repaired.

If the leg of a lobster be broken off by design at the fourth or fifth articulation, what is thus broke off is always reproduced. But if the fracture be made in the first, second, or third articulation, the reproduction is not so certain. And it is very surprising, that, if the fracture be made at these articulations, at the end of two or three days, all the other articulations are generally found broke off to the fourth, which, it is supposed, is done by the creature itself, to make the reproduction certain. The part reproduced is not only perfectly similar to that retrenched, but also, in a certain space of time, grows equal to it. Hence it is that we frequently see lobsters, which have their two large legs unequal in all proportions. And if the part reproduced be broken off, a second will succeed.

REPTILIA, in natural history, an order of Amphibia, the character of which is, that they breathe through the mouth; have feet, and flat naked ears without auricles. There are five genera; viz.

Draco	Siren
Lacerta	Tertudo.
Rana	

REPULSION, in physics, that property in bodies, whereby, if they are placed just beyond the sphere of each other's attraction of cohesion, they mutually fly from each other. Thus, if an oily substance, lighter than water, be placed on the surface thereof, or if a piece of iron be laid upon mercury, the surface of the fluid will be depressed about the body laid on it: this depression is manifestly occasioned by a repelling power in the bodies, which hinders the approach of the fluid towards them. But it is possible, in some cases, to press or force the repelling bodies into the sphere of one another's attraction; and then they will mutually tend towards each other, as when we mix oil and water till they incorporate. Dr. Knight defines repulsion to be that cause which makes bodies mutually endeavour to recede from each other, with different forces, at different times; and that such a cause exists in nature, he thinks evident for the following reasons. 1. Because all bodies are

electrical, or capable of being made so; and it is well known, that electrical bodies both attract and repel. 2. Both attraction and repulsion are very conspicuous in all magnetical bodies. 3. Sir Isaac Newton has shown from experiments, that the surfaces of two convex glasses repel each other. 4. The same great philosopher has explained the elasticity of the air, by supposing its particles mutually to repel each other. 5. The particles of light are, in part at least, repelled from the surfaces of all bodies. 6. Lastly, it seems highly probable, that the particles of light mutually repel each other, as well as the particles of air. The same gentleman ascribes the cause of repulsion, as well as that of attraction, to the immediate effect of God's will; and as attraction and repulsion are contraries, and consequently cannot, at the same time, belong to the same substance, the doctor supposes there are in nature two kinds of matter, one attracting, the other repelling; and that those particles of matter which repel each other, are subject to the general law of attraction in respect of other matter. A repellent matter being thus supposed, equally dispersed through the whole universe, the doctor attempts to account for many natural phenomena by means thereof. He thinks light is nothing but this repellent matter put into violent vibrations, by the repellent corpuscles which compose the atmosphere of the sun and stars: and that, therefore, we have no reason to believe they are gulphs of fire, but, like the rest of the heavenly bodies, inhabitable worlds. From the same principles, he attempts to explain the nature of fire and heat, the various phenomena of the magnet, and the cause of the variation of the needle: and, indeed, it is difficult, if not impossible, by the doctrine of attraction alone, to account for all the phenomena observable in experiments made with magnets, which may now be solved by admitting this doctrine of a repellent fluid; but whether it will be sufficient to account for all the particular phenomena of nature, which are the proper tests of an hypothesis, time and experience alone must determine. The doctor also endeavours to show, that the attractions of cohesion, gravity, and magnetism, are the same, and that by these two active principles, *viz.* attraction and repulsion, all the phenomena of nature may be explained; but as his ingenious treatise on this subject is laid down in a series of propositions, all connected together, it would be impossible to do justice to his arguments without transcribing the whole: we shall therefore refer the curious to the book itself.

According to 'sGravesande and others, when light is reflected from a polished spherical surface, the particles of light do not strike upon the solid parts, and so rebound from them; but are repelled from the surface, at a small distance before they touch it, by a power extended all over the said polished surface. And Sir Isaac Newton observes, that the rays of light are also expelled by the edges of bodies, as they pass near them; so as to make their shadows, in some cases, larger than they would otherwise be.

REPULSION, in chemistry. Sir Isaac Newton demonstrated, that if this law be correct, then the force, by which the particles of air recede from each other, increases or diminishes at the same rate that the distance between the centres of the particles, or atoms, of which it is composed, diminishes or increases; or, which is the same thing, that the repulsion between the particles of gaseous bodies is always inversely as the distance of their centres from each other. Now the distance between the centres of the atoms of elastic fluids always varies as the cube root of their density, taking the word in its common acceptation. Thus, if the density of air, under the mean pressure of the atmosphere, be supposed 1; if it be forced into $\frac{1}{8}$th of its bulk, its density becomes 8. In these two cases we have the distance between the atoms of air inversely as the cube root of 1 to the cube root of 8, or as 1 to 2. So that if air be compressed into $\frac{1}{8}$th of its bulk, the distance between its particles is reduced to one *half*, and of course the repulsion between them is doubled. If air be rarified 300 times, we have its density reduced to $\frac{1}{300}$th of that of common air. Here we have the distance between the atoms of common and the rarefied air, as $\sqrt[3]{3} : \sqrt[3]{300}$, or nearly as 1 : 7. So that when air is rarefied 300 times, the distance between its particles becomes almost seven times greater, and of course their repulsion is diminished almost sevenfold.

RESCUE, or Rescous, is the taking away and setting at liberty, *against law*, any distress taken for rent, or services, or damage feasant; but the more general notion of rescous is, the *forcibly liberating* another from an arrest or some legal commitment. This is a high offence, and subjects the offender not only to an action at

the suit of the party injured, but likewise to fine and imprisonment at the suit of the king. If goods are distrained without cause, or contrary to law, the owner may make rescue; but if they are once impounded, even though taken without any cause, the owner may not break the pound and take them out, for then they are in custody of the law.

RESEDA, in botany, a genus of the Dodecandria Trigynia class and order. Natural order of Miscellaneæ. Capparides, Jussieu. Essential character: calyx one-leafed, parted; petals laciniate; capsule gaping at the mouth, one-celled. There are thirteen species; none of these plants, except the R. odorata, sweet reseda, or mignonette, are cultivated in gardens, unless for the sake of variety, having little beauty to recommend them. The root of the mignonette is composed of many strong fibres, which run deep into the ground: it has several stems, about a foot long, dividing into many small branches; leaves oblong, of a deep green colour; the flowers are produced in loose spikes at the ends of the branches, on long foot-stalks, having large calyxes; the corollas are of an herbaceous white colour. It is supposed to be a native of Egypt.

RESIDENCE, is particularly used for the continuance of a parson or vicar on his benefice. By stat. 13 Elizabeth, c. 20, and divers other subsequent statutes, if any beneficed clergyman be absent from his cure above fourscore days in one year, he shall not only forfeit one year's profit of his benefice, to be distributed among the poor of the parish, but all leases made by him of the profits of such benefice, and all covenants and agreements of like nature, shall cease and be void, except in the case of licensed pluralists, who are allowed to demise the living on which they are non-resident to their curates only.

RESIDUAL *figure*, in geometry, the figure remaining after subtracting a lesser from a greater.

RESIDUAL *root*, in algebra, a root composed of two parts or members, connected together by the sign —. Thus $x-y$ is a residual root, so called, because its value is no more than the difference between its parts x and y.

RESIDUARY *Legatee*, is he to whom the residue of a personal estate is given by will; and such legatee being made executor with others, shall retain against the rest. If there is no residuary clause in a will, all the property which is not particularly devised goes to the executor, if it is personal; but, if real, to the heir.

RESIGNATION, the giving up a benefice into the hands of the ordinary. Every person who resigns a benefice must make the resignation to his superior; as an incumbent to a bishop; a bishop to an archbishop; and an archbishop to the king, as supreme ordinary.

RESINS. Resinous bodies form a very numerous class of vegetable substances. When volatile oils are exposed to the air, they become thick after a shorter or longer time, and are then found to be converted into a resin. The oil absorbs oxygen from the air, and is deprived of part of its carbon, which combining with the oxygen of the atmosphere, forms carbonic acid. Resinous substances, therefore, are generally considered as volatile oils saturated with oxygen. The general properties of resinous substances are the following. They are solid, brittle, and commonly of a yellowish colour, with some degree of transparency. The taste, resembling volatile oils, is hot and acrid. They have no smell. The specific gravity is from 1.01 to 1.22. All resinous bodies are electrics, and when excited by friction the electricity is negative; hence it is called resinous electricity. They melt by being exposed to heat, and burn with a yellow flame, giving out a great quantity of smoke. Resins are insoluble in water. Resinous substances are soluble in nitric acid; part is precipitated by the addition of water, and the whole by means of the alkalies. With the assistance of heat they are all soluble in alcohol, and in sulphuric ether. Resins are soluble in some of the fixed oils, and also in volatile oils. Resinous substances have been found to be soluble in the fixed alkalies. We shall enumerate some of the resins which are best known, and which have not already been described in separate articles.

Rosin. This substance is extracted from different species of the fir, and the resinous matter obtained from it has received different names. That procured from the pinus sylvestris is the common turpentine; from the pinus larix, Venice turpentine; and from the pinus balsamea, balsam of Canada. The turpentine is obtained by stripping the bark off the trees; a liquid juice flows out, which gradually hardens. This juice consists of oil of turpentine and rosin. By distilling the turpentine the oil passes over, and the rosin remains behind.

By distilling to dryness common rosin is obtained. When water is added, while it is yet fluid, and incorporated by agitation, what is called yellow rosin is formed.

Pitch is a resinous juice obtained from the pinus picea, pitch pine. It is purified by melting and squeezing it through linen bags, and it is then known by the name of white, or Burgundy pitch. White pitch mixed with lamp-black forms black pitch.

Sandarac. This resinous substance is extracted from the juniper. It is a spontaneous exudation from this plant in the form of brown tears, which are semitransparent and brittle. See BALSAM, COPAL, GUIACUM, &c.

RESISTANCE, or RESISTING *force*, in philosophy, denotes, in general, any power which acts in an opposite direction to another, so as to destroy or diminish its effect. Hence the force wherewith bodies, moving in fluid mediums, are impeded or retarded, is the resistance of those fluids. Authors have established it as a certain rule, that, whilst the same body moves in the same medium, it is always resisted in the duplicate proportion of its velocity; that is, if the resisted body move in one part of its track with three times the velocity with which it moved in some other part, then its resistance to the greater velocity will be nine times the resistance to the lesser: if the velocity in one place be four times the velocity in another, the resistance to the greater velocity will be sixteen times the resistance to the lesser, and so on. This rule, though very erroneous, when taken in a general sense, is yet undoubtedly very near the truth, when confined within certain limits.

In order to conceive the resistance of fluids to a body moving in them, Mr. Robins distinguishes between those fluids, which being compressed by some incumbent weight, perpetually close up the space deserted by the body in motion, without permitting, for an instant, any vacuity to remain behind it; and those fluids in which, they being not sufficiently compressed, the space left behind the moving body remains for some time empty. These differences in the resisting fluids will occasion very remarkable varieties in the laws of their resistance, and are absolutely necessary to be considered in the determination of the action of the air in shot and shells; for the air partakes of both these affections, according to the different velocities of the projected body. If a fluid were so constituted, that all the particles composing it were at some distance from each other, and there was no action between them, then the resistance of a body moving therein would be easily computed from the quantity of motion communicated to these particles: for instance, if a cylinder moved in such a fluid in the direction of its axis, it would communicate to the particles it met with a velocity equal to its own, and in its own direction, supposing that neither the cylinder nor the parts of the fluid were elastic; whence, if the velocity and diameter of the cylinder be known, and also the density of the fluid, there would thence be determined the quantity of motion communicated to the fluid, which (action and re-action being equal) is the same with the quantity lost by the cylinder, consequently the resistance would be hereby ascertained.

In this kind of discontinued fluid, the particles being detached from each other, every one of them can pursue its own motion in any direction, at least for some time, independently of the neighbouring ones; wherefore, if instead of a cylinder moving in the direction of its axis, a body, with a surface oblique to its direction, be supposed to move in such a fluid, the motion the parts of the fluid will hereby acquire, will not be in the direction of the resisted body, but perpendicular to its oblique surface; whence the resistance to such a body will not be estimated from the whole motion communicated to the particles of the fluid, but from that part of it only which is in the direction of the resisted body. In fluids then, where the parts are thus discontinued in each other, the different obliquities of that surface, which goes foremost, will occasion considerable changes in the resistance; although the section of the solid, by a plain perpendicular to its direction, should in all cases be the same. And Sir Isaac Newton has particularly determined, that in a fluid thus constituted the resistance of a globe is but half the resistance of a cylinder of the same diameter, moving in the direction of its axis with the same velocity.

But though the hypothesis of a fluid, thus constituted, be of great use in explaining the nature of resistances, yet in reality no such fluid does exist within our knowledge: all the fluids with which we are conversant are so formed, that their particles either lie contiguous to each other, or at least act on each other in the same manner as if they did; consequently, in these fluids, no one particle, contiguous to the resisted body,

can be moved, without moving at the same time a great number of others, some of which will be distant from it; and the motion thus communicated to a mass of the fluid will not be in any one determined direction, but will in each particle be different, according to the different manners in which it lies in contact with those from which it receives its impulse; whence great numbers of the particles being diverted into oblique directions, the resistance of the moving body, which will depend on the quantity of motion communicated to the fluid in its own direction, will be hereby different in quantity from what it would be in the preceding supposition, and its estimation becomes much more complicated and operose. Sir Isaac Newton, however, has determined, that the resistance to a cylinder, moving in the direction of its axis in such a compressed fluid as we have here treated off, is but one-fourth part of the resistance, which the same cylinder would undergo if it moved with the same velocity in a fluid constituted in the manner we have described in our first hypothesis, each fluid being supposed to be of the same density. But again, it is not only in the quantity of their resistance that these fluids differ, but likewise in the different manner in which they act on solids of different forms moving in them.

We have shown, that in the discontinued fluid, which we first described, the obliquity of the foremost surface of the moving body would diminish the resistance; but in compressed fluids this holds not true, at least not in any considerable degree: for the principal resistance in compressed fluids arises from the greater or lesser facility with which the fluid, impelled by the forepart of the body, can circulate towards its hindermost part; and this being little, if at all, affected by the form of the moving body, whether it be cylindrical, conical, or spherical, it follows, that while the transverse section of the body, and consequently the quantity of impelling fluid is the same, the change of figure in the body will scarcely affect the quantity of its resistance.

The resistance of bodies of different figures, moving in one and the same medium, has been considered by M. J. Bernouli, and the rules he lays down on this subject are the following: 1. If an isosceles triangle be moved in the fluid according to the direction of a line which is normal to its base; first with the vertex foremost, and then with its base; the resistances will be as the legs; and as the square of the base, and as the sum of the legs. 2. The resistance of a square moved according to the direction of its side, and of its diagonal, is as the diagonal to the side. 3. The resistance of a circular segment (less than a semicircle) carried in a direction perpendicular to its basis, when it goes with the base foremost, and when with its vertex foremost (the same direction and celerity continuing, which is all along supposed) is as the square of the diameter to the same, less one-third of the square of the base of the segment. Hence the resistances of a semicircle, when its base, and when its vertex go foremost, are to one another in a sesquialterate ratio. 4. A parabola moving in the direction of its axis, with its basis, and then its vertex foremost, has its resistances, as the tangent to an arch of a circle, whose diameter is equal to the parameter, and the tangent equal to half the basis of the parabola. 5. The resistances of an hyperbola, or the semi-ellipsis, when the base and when the vertex go foremost, may be thus computed; let it be, as the sum, or difference, of the transverse axis and latus rectum is to the transverse axis, so is the square of the latus rectum to the square of the diameter of a certain circle; in which circle apply a tangent equal to half the basis of the hyperbola or ellipsis. Then say again, as the sum, or difference, of the axis and parameter is to the parameter, so is the aforesaid tangent to another right line. And further, as the sum, or difference, of the axis and parameter is to the axis, so is the circular arch corresponding to the aforesaid tangent, to another arch. This done, the resistances will be as the tangent to the sum, or difference, of the right line thus found, and that arch last mentioned. 6. In general, the resistances of any figure whatsoever, going now with its base foremost, and then with its vertex, are as the figures of the basis to the sum of all the cubes of the element of the basis divided by the squares of the element of the curve line. All which rules, he thinks, may be of use in the fabric or construction of ships, and in perfecting the art of navigation universally. As also for determining the figures of the balls of pendulums for clocks.

As to the resistance of the air, Mr. Robins, in his new principles of gunnery, took the following method to determine it: he charged a musket-barrel three times successively with a leaden ball $\frac{3}{4}$ of an inch diameter, and took such precaution in weighing of the powder, and placing it, as

to be sure, by many previous trials, that the velocity of the ball could not differ by 20 feet in 1″ from its medium quantity. He then fired it against a pendulum, placed at 25, 75, and 125 feet distance, &c. from the mouth of the piece respectively. In the first case it impinged against the pendulum with a velocity of 1670 feet in 1″; in the second case, with a velocity of 1550 feet in 1″; and in the third case, with a velocity of 1425 feet in 1″; so that in passing through 50 feet of air, the bullet lost a velocity of about 120, or 125 feet in 1″; and the time of its passing through that space being about $\frac{1}{32}$ or $\frac{1}{30}$ of 1″, the medium quantity of resistance must, in these instances, have been about 120 times the weight of the ball; which, as the ball was nearly $\frac{1}{12}$ of a pound, amounts to about 10*lb.* avoirdupoise.

Now if a computation be made, according to the method laid down for compressed fluids in the thirty-eighth Propos. of lib. 2. of Sir Isaac Newton's Principia, supposing the weight of water to be to the weight of air as 850 to 1, it will be found that the resistance of a globe of three quarters of an inch diameter, moving with a velocity of about 1600 feet in 1″, will not, on those principles, amount to any more than a force of $4\frac{1}{2}$*lb.* avoirdupoise; whence we may conclude (as the rules in that proposition for slow motions are very accurate) that the resisting power of the air in slow motions is less than in swift motions, in the ratio of $4\frac{1}{2}$ to 10, a proportion between that of 1 and 2, and 1 to 3.

Again, charging the same piece with equal quantities of powder, and balls of the same weight, and firing three times at the pendulum, placed at 25 feet distance from the mouth of the piece, the medium of the velocities with which the ball impinged was 1690 feet in 1″. Then removing the piece 175 feet from the pendulum, the velocity of the ball, at a medium of five shots, was 1300 feet in 1″. Whence the ball, in passing through 150 feet of air, lost a velocity of about 390 feet in 1″; and the resistance, computed from these numbers, comes out something more than in the preceding instance, amounting to between 11 and 12 pounds avoirdupoise: whence, according to these experiments, the resisting power of the air to swift motions is greater than in slow ones, in a ratio which approaches nearer to the ratio of 3 to 1, than in the preceding experiments.

Having thus ascertained the resistance to a velocity of near 1700 feet in 1″, he next proceeded to examine this resistance in smaller velocities: the pendulum being placed at 25 feet distance, was fired at five times, and the mean velocity with which the ball impinged was 1180 feet in 1″. Then removing the pendulum to the distance of 250 feet, the medium velocity of five shot at this distance, was 950 feet in 1″; whence the ball, in passing through [illegible] feet of air, lost a velocity of 230 feet in 1″. and as it passed through that interval in about $\frac{1}{4}$ of 1″, the resistance to the middle velocity will come out to be near $33\frac{1}{2}$ times the gravity of the ball, or 2*lb.* 10*oz.* avoirdupoise. Now the resistance to the same velocity, according to the laws observed in slower motions, amounts to $\frac{7}{11}$ of the same quantity; whence in a velocity of 1065 feet in 1″, (the medium of 1180 and 950) the resisting power of the air is augmented in no greater proportion than of 11 to 7; whereas in greater degrees of velocity, as before, it amounted very near the ratio of 3 to 1.

That this resisting power of the air to swift motions is very sensibly increased beyond what Sir Isaac's theory for slow motions makes it, seems hence to be evident. It being, as has been said, in musket, or cannon-shot, with their full charge of powder, nearly three times the quantity assigned by that theory.

The resistance of a bullet of three quarters of an inch diameter, moving in air with a velocity of 1670 feet in 1″, amounting, as we said, to 10*lb.* the resistance of a cannon-ball of 24*lb.* fired with its full charge of powder, and thereby moving with a velocity of 1650 feet in 1″, may hence be determined. For the velocity of the cannon-ball being nearly the same as the musket-bullet, and its surface above 54 times greater, it follows that the resistance on the cannon-ball will amount to more than 540*lb.* which is near 23 times its own weight. And from hence it appears how rash and erroneous the opinion of those is, who neglect the consideration of the resistance of the air as of no importance in the doctrine of projectiles. See Robins's Tracts; Hutton's Dictionary, article Resistance.

RESOLUTION, or Solution, in mathematics, is an orderly enumeration of several things to be done, to obtain what is required in a problem.

Resolution, in algebra, or *algebraical resolution*, is of two kinds; the one practised in numerical problems, the other in geometrical ones.

In resolving a numerical problem alge-

braically, the method is this: First, the given quantities are distinguished from those that are sought; and the former denoted by the initial letters of the alphabet, but the latter by the last letters. 2. Then as many equations are formed as there are unknown quantities. If that cannot be done from the proposition or data, the problem is indeterminate; and certain arbitrary assumptions must be made to supply the defect, and which can satisfy the question. When the equations are not contained in the problem itself, they are to be found by particular theorems concerning equations, ratios, proportions, &c. Since, in an equation the known and unknown quantities are mixed together, they must be separated in such a manner that the unknown remain alone on one side, and the known ones on the other. This reduction, or separation, is made by addition, subtraction, multiplication, division, extraction of roots, and raising of powers; resolving every kind of combination of the quantities, by their counter or reverse ones, and performing the same operation on all the quantities, or terms, on both sides of the equation, that the equality may still be preserved.

To resolve a geometrical problem algebraically. The same sort of operations are to be performed as in the former article; besides several others, that depend upon the nature of the diagram, and geometrical properties. As, 1. The thing required or proposed, must be supposed done, the diagram being drawn or constructed in all its parts, both known and unknown. 2. We must then examine the geometrical relations which the lines of the figure have among themselves, without regarding whether they are known or unknown, to find what equations arise from those relations, for finding the unknown quantities. 3. It is often necessary to form similar triangles and rectangles, sometimes by producing of lines, or drawing parallels and perpendiculars, and forming equal angles, &c.; till equations can be formed from them, including both the known and unknown quantities.

Resolution, in chemistry, &c. the reduction of a mixed body into its component parts, or first principles, by a proper analysis. The resolution of bodies is effected by divers operations, as distillation, sublimation, fermentation, precipitation, &c. See Distillation, Sublimation, &c.

Some logicians use the term resolution for what is more usually called analysis, or the analytic method.

Resolution *of forces*, or *of motion*, is the resolving or dividing of any one force or motion, into several others, in other directions, but which, taken together, shall have the same effect as the single one; and it is the reverse of the composition of forces or motions.

RESPIRATION, in animal economy. The absolute necessity of respiration, or of something analogous, is known to every one; and few are ignorant that in man, and hot-blooded animals, the organ by which respiration is performed is the lungs. Now respiration consists in drawing a certain quantity of air into the lungs, and throwing it out again alternately. Whenever this function is suspended, even for a very short time, the animal dies. The fluid respired by animals is common atmospherical air; and it has been ascertained by experiment, that no other gaseous body with which we are acquainted can be substituted for it. All the known gases have been tried; but they all prove fatal to the animal which is made to breathe them. Gaseous bodies, as far as respiration is concerned, may be divided into two classes: — 1. Unrespirable gases. 2. Respirable gases. The gases belonging to the first class are of such a nature, that they cannot be drawn into the lungs of an animal at all; the epiglottis closing spasmodically whenever they are applied to it. To this class belong carbonic acid, and probably all the other acid gases, as has been ascertained by the experiments of Pilâtre de Rozier, who went into a brewer's tub while full of carbonic acid gass evolved by fermentation. A gentle heat manifested itself in all parts of his body, and occasioned a sensible perspiration. A slight itching sensation constrained him frequently to shut his eyes. When he attempted to breathe, a violent feeling of suffocation prevented him. He sought for the steps to get out; but not finding them readily, the necessity of breathing increased, he became giddy, and felt a tingling sensation in his ears. As soon as his mouth reached the air he breathed freely; but for some time he could not distinguish objects: his face was purple, his limbs weak, and he understood with difficulty what was said to him. But these symptoms soon left him. He repeated the experiment often; and always found, that as long as he continued without breathing, he could speak and move about without inconvenience; but whenever he attempted to breathe, the feeling of suffocation came on. For the lungs of animals suffocated by

it were found by Pilatré not to give a green colour to vegetable blues. The gases belonging to the second class may be drawn into the lungs, and thrown out again without any opposition from the respiratory organs; of course the animal is capable of respiring them. They may be divided into four subordinate classes: — 1. The first set of gases occasion death immediately, but produce no visible change in the blood. They occasion the animal's death merely by depriving him of air, in the same way as he would be suffocated by being kept under water. The only gases which belong to this class are hydrogen and azotic. 2. The second set of gases occasion death immediately; but at the same time they produce certain changes in the blood, and therefore kill, not merely by depriving the animal of air, but by certain specific properties. The gases belonging to this class are carbureted hydrogen, sulphureted hydrogen, carbonic oxide, and perhaps also nitrous gas. 3. The third set of gases may be breathed for some time without destroying the animal; but death ensues at last, provided their action be long enough continued. To this class belong the nitrous oxide and oxygen gas. 4. The fourth set may be breathed any length of time without injuring the animal. Air is the only gaseous body belonging to this class. See PHYSIOLOGY, and Thomson's Chemistry.

RESPONDEAS *ouster*, is to answer over in an action to the merits of the cause. As if a demurrer is joined upon a plea to the jurisdiction, person, or writ, and it be adjudged against the defendant, it is a *respondeas ouster*.

REST, the continuance of a body in the same place, or its continual application or contiguity to the same parts of the ambient or contiguous bodies; and therefore is opposed to motion. Sir Isaac Newton defines true or absolute rest to be the continuance of a body in the same part of absolute space; and relative rest to be the continuance of a body in the same part of relative space. Thus, in a ship under sail, relative rest is the continuance of a body in the same part of the ship; but absolute is its continuance in the same part of universal space, in which the ship itself is contained. It is one of the laws of nature, that matter is indifferent to motion or rest, as has been shown under the article INERTIA.

REST, in poetry, is a short pause of the voice in reading, being the same with the cæsura, which, in Alexandrian verses, falls on the sixth syllable; but in verses of ten or eleven syllables, on the fourth.

RESTIO, in botany, a genus of the Diœcia Triandria class and order. Natural order of Calamariæ. Essential character: calyx three-leaved, two of the leaflets boat-shaped; corolla three-leaved, leaflets lanceolate, one wider: female, germ three-sided, style one, seldom two or three; stigmas one, two, three, feathered. There are twenty-eight species. These plants are all natives of the Cape of Good Hope, where some of them are used for making ropes, for brooms, or for thatching.

RESULTING *use*, in law, is when an use limited by a deed expires, or cannot vest, it returns back to him who raised it. See USES.

RETAINER *of debts*, an executor, among debts of equal degree, may pay himself first, by retaining in his hands, the amount of his debt.

RETARDATION, in physics, the act of diminishing the velocity of a moving body. If bodies of equal bulk, but of different densities, be moved through the same resisting medium, with equal velocity, the medium will act equally on each, so that they will have equal resistances, but their motions will be unequally retarded, in proportion to their densities. Retarded motion from gravity is peculiar to bodies projected upwards, and this in the same manner as a falling body is accelerated; only in the latter, the force of gravity acts in the same direction with the motion of the body; and in the former in an opposite direction. As it is the same force which augments the motion in the falling, and diminishes it in the rising body, a body will rise till it has lost all its motion; which it does in the same time wherein a body falling would have acquired a velocity equal to that wherewith the body was projected upwards.

RETE *mucosum*, in animal economy, is the mucous substance, situated between the cutis vera and epidermis, its composition cannot be determined with precision, because its quantity is too small to admit of examination. It is known, that the black colour of negroes depends upon a black pigment, situated in this substance. Oxymuriatic acid deprives it of its black colour, and renders it yellow. A negro, by keeping his foot for some time in water impregnated with that acid, deprived it of its colour, and rendered it nearly white; but in a few days the black colour returned again with its former intensity. This experiment was first made by Dr. Beddoes, on the fingers of a negro.

RETENTION. Whatever be the effect produced in the mental organs by the impressions on the organs of sense, that effect can be renewed, though in general with diminished vigour, without a repetition of the sensible impressions. In other words, sensible changes produce a tendency to similar changes, which can be repeated without the repetition of the external impressions, and may then be called ideal changes. Less generally sensations leave relicts behind them, which can be perceived without the agency of the external organs of sensation, and which are called ideas. The power or capacity of the mind by which tendencies to ideal changes are retained, may be called the retentive power.

That tendencies to a repetition of sensorial changes are thus formed, that ideas are thus retained, may be referred to the operation of the associative power, and in the human being they certainly depend upon the same organic causes, whatever those be. But in many animals it is decidedly probable that sensations leave no relicts behind them; and in man there are, equally probably, numerous impressions from external objects, which leave no relicts behind them. Again, these relicts of sensations can reappear without the agency of external objects. Hence it appears preferable to consider the receiving of sensations, and the retaining of ideas, as two separate, though intimately connected operations, and as implying two separate powers or capacities of the mind. This is not done by Hartley, who appears to refer both to sensation; but it has subjected him to some apparently just, though in reality unfounded animadversions of the great northern philosopher, Dugald Stewart. Speaking of the phenomena of memory as not to be intirely explained by the law of association, he says, (p. 412.) "The association of ideas connects our various thoughts with each other so as to present them to the mind in a certain order, but it presupposes a faculty of retaining the knowledge we acquire." This Hartley knew, and has accordingly a distinct section on the generation of ideas.

Without the retentive power it is obvious that man would be a being of mere sensation, little, if any, superior to the lowest orders of the animal creation, and inferior to many of them. The retentive power provides materials for the agency of the associative power. Without the retentive power the associative power would never be called into exercise, and without the associative power, the relicts of sensation, the effects of the retentive power would be of no utility. The operations of the retentive power can scarcely be separated from those of the associative power, which together constitute the compound faculty called memory, for an account of which see PHILOSOPHY, *mental*, § 105.

We have said that the receiving of sensations, and the retaining the relicts of them, seem to depend upon the same organic causes whatever they be. In some instances sensible changes perceptibly continue after the sensible objects are removed. Two or three facts, which every one must have noticed, or may notice, will illustrate this principle. If a piece of stick be burnt at one end, and the lighted end be turned quickly round in a circle, the luminous point will appear to the eye as a complete luminous circle; the changes of the optic organs continuing till the image of the luminous point returns to any given point of the retina. Again, the sensible changes produced by sound, perceptibly continue after the external cause ceases. If a sounding body be struck very rapidly with a stick, we do not perceive any interval, and as Hartley observes, the most simple sounds which we hear, being reflected from the neighbouring bodies, consist of a number of sounds succeeding each other at different distances of time, according to the distances of the reflecting bodies. The sensible changes produced by the other senses, also continue some time after the impressions which have been made upon them. If a hard body be pressed upon the palm of the hand, it is not easy to distinguish, for a few seconds, whether it remains or is removed. And tastes continue to be perceived long after the sapid material is withdrawn.

This play of the organs, (which however is rather to be referred to the external than to the mental organs), gives rise, in the case of vision, to a number of very singular and interesting phenomena, by some philosophers called *ocular spectra*. A considerable variety of them are stated by Dr. R. Darwin, of Shrewsbury, at the end of the second part of Darwin's Zoonomia. We shall select a few of the most striking.

Place about half an inch square of white paper on a black hat, and looking steadily on the centre of it for a minute, remove your eyes to a sheet of white paper; after a second or two a dark square will be seen on the white paper, which will be seen for

some time. A similar dark square will be seen in the closed eye, if light be admitted through the eye-lids. So after looking at any luminous body of a small size, as at the Sun, for a short time, so as not much to fatigue the eyes, this part of the retina becomes less sensible to smaller quantities of light: hence when the eyes are turned upon other less luminous parts of the sky, a dark spot is seen resembling the shape of the luminous body. To the same cause Dr. R. Darwin ascribes those dark coloured floating spots which are easily perceptible when the eyes are a little weakened by fatigue, and during illnesses which are attended with great debility. He says, that as these spectra are most easily discernible when our eyes are weakened by fatigue, it has frequently happened that people of delicate constitutions have been much alarmed at them, fearing a beginning decay of their sight, and thence have fallen into the hands of ignorant oculists. They are not, however, he observes, the preludes to any disease, and it is only from our habitual inattention to them that we do not see them on all objects every hour of our lives. As the nerves of very weak people, he continues, lose their sensibility by a small duration of exertion, it frequently happens that sick people, in the extreme debility of fevers, are perpetually employed in picking something off from the bed clothes, owing to their mistaking the cause of these dark spots. An Italian artist, a man of strong abilities, relates, that having passed the whole night on a distant mountain, with some companions and a conjuror, and performed many ceremonies to raise the devil, on their return in the morning to Rome, looking up when the sun began to rise, they saw numerous devils run on the tops of the houses as they passed along. So much were the spectra of their weakened eyes magnified by fear, and made subservient to the purposes of fraud or superstition.

Again, make with ink, on white paper, a very black spot about half an inch in diameter, with a tail about an inch in length, so as to represent a tadpole. Look steadily at this spot for about a minute, and on moving the eye a little, the figure of the tadpole will be seen on the white part of the paper, which figure will appear whiter or more luminous than the other part of the paper. This Dr. R. Darwin brings as one proof, that when the retina has been subjected to a less excitement, it is more easily brought into action by being subjected to a greater. A surface appears black in consequence of its absorbing all the rays of light; that part of the retina, therefore, which is unemployed while looking at the spot, is afterwards more sensible of the light from the white paper, than those parts which had previously been exposed to it. On closing the eyes after viewing the black spot on the white paper, a red spot is seen of the form of the black spot; for that part of the retina on which the figure of the black spot was formed, being more sensible to the light than the other parts, is capable of being brought into action by the red rays which penetrate the eye-lids. Upon the same principle Dr. R. Darwin accounts for the following fact. A writer in the Berlin Memoires observes, that when he held a book, so that the sun shone upon his half closed eye-lids, the black letters which he had long inspected, became red. There is a similar story told by Voltaire of a Duke of Tuscany, who was playing at dice with a general of a foreign army, and believing that he saw red spots on the dice, portended dreadful events, and retired in confusion. The observer, after looking for a minute on the black spots of a die, in a bright day, and carelessly closing his eyes would see red spots corresponding to the black spots on the die, and if they were intense from the fatigue or weakness of the optic organ, those appearances would continue, and on looking at the die, would be supposed to be upon it, just as before stated. persons in a very weak state often see black spots which they refer to the bed clothes.

RETICULA, or RETICULE, in astronomy, a contrivance for the exact measuring the quantity of eclipses. The *reticule* is a little frame, consisting of thirteen fine silken threads, equidistant from each other, and parallel, placed in the focus of object-glasses of telescopes; that is, in the place where the image of the luminary is painted in its full extent; of consequence, therefore, the diameter of the sun or moon is hereby seen divided into twelve equal parts or digits; so that to find the quantity of the eclipse, there is nothing to do but to number the luminous and the dark parts. As a square reticule is only proper for the diameter, not for the circumference, of the luminary, it is sometimes made circular by drawing six concentric equi-distant circles. This represents the phases of the eclipse perfectly.

RETINA, in anatomy, the expansion of

the optic nerve on the internal surface of the eye, whereupon the images of objects being painted, are impressed, and by that means conveyed to the common sensory in the brain, where the mind views and contemplates their ideas. See OPTICS.

RETORNO *habendo*, in law. See REPLEVIN.

RETORT. See LABORATORY.

RETRAXIT, in law, is where the plaintiff or demandant comes in person into the court, and says he will proceed no further; and this is a bar of all other actions of like or inferior nature.

RETRENCHMENT, in the art of war, any kind of work raised to cover a post, and fortify it against the enemy, such as fascines loaded with earth, gabions, barrels of earth, sand-bags, and generally all things that can cover the men and stop the enemy. But retrenchment is more particularly applicable to a foss bordered with a parapet; and a post fortified thus is called post retrenched, or strong post. Retrenchments are either general or particular: general retrenchments are new fortifications made in a place besieged, to cover the besiegers when the enemy become masters of a lodgment on the fortification, that they may be in a condition of disputing the ground inch by inch, and of putting a stop to the enemy's progress in expectation of relief. Particular retrenchments are such as are made in the bastions, when the enemy are masters of the breach. These can never be made but in new full bastions, for in empty, or hollow ones, there can only be made retirades. The particular retrenchments are made several ways, according to the time they have to cover themselves: sometimes they are made before hand, which are certainly the best. The parapets of such retrenchments ought to be five or six feet thick, and five feet high, with a large and deep foss, from whence ought to run out small fougades and countermines.

RETROGRADATION, in astronomy, is an apparent motion of the planets, by which they seem to go backwards in the ecliptic, and to move contrary to the order of the signs, as from Aries to Taurus; from Taurus to Gemini, &c. which, from west to east, it is said to be direct. When it appears for some days in the same place or point in the heavens, it is said to be stationary; and when it goes in antecedentia, or backwards, or contrary to the order of the signs, which is from east to west, it is said to be retrograde. Saturn continues retrograde about 140 days; Jupiter 120; Mars 73; Venus 42; and Mercury 22. The interval between two retrogradations of the several planets are as follow:

In Saturn	it is about 378 days;
Jupiter	.... 408 ——
Mars	.... 780 ——
Venus	.... 585 ——
Mercury	.... 115 ——

RETROMINGENTS, in natural history, a class or division of animals, whose characteristic it is that they stale, or make water backwards, both male and female.

RETURN, is most commonly used for the return of writs, which is the certificate of the Sheriff made to the court of what he has done, touching the execution of any writ directed to him; and where a writ is executed, or the defendant cannot be found, or the like, this fact is indorsed on the writ by the officer, and delivered into the court whence the writ issued, at the day of the return thereof, in order to be filed.

RETURNING *stroke*, in electricity, is an expression used by Lord Mahon, (now Earl Stanhope), to denote the effect produced by the return of the electric fluid into a body from which, under certain circumstances, it has been expelled.

To understand properly the meaning of these terms, it must be premised, that according to the author's experiments, an insulated smooth body, immerged within the electrical atmosphere, but beyond the striking distance of another body, charged positively, is at the same time in a state of threefold electricity. The end next to the charged body acquires negative electricity; the further end is positively electrified; while a certain part of the body, somewhere between its two extremes, is in a natural, unelectrified, or neutral state; so that the two contrary electricities balance each other. It may further be added, that if the body be not insulated, but have a communication with the earth, the whole of it will be in a negative state. Suppose, then, a brass ball, which may be called A, to be constantly placed at the striking distance of a prime conductor, so that the conductor, the instant when it becomes fully charged, explodes into it. Let another large or second conductor be suspended in a perfectly insulated state, further from the prime conductor than the striking distance, but within its electrical atmosphere: let a person, standing on an insu-

lated stool, touch this second conductor very lightly with a finger of his right hand; while with a finger of his left hand he communicates with the earth, by touching very lightly a second brass ball, fixed at the top of a metallic stand, on the floor, which may be called B. Now, while the prime conductor is receiving its electricity, sparks pass (at least if the distance between the two conductors is not too great) from the second conductor to the right hand of the insulated person; while similar and simultaneous sparks pass out from the finger of his left hand into the second metallic ball, B, communicating with the earth. At length, however, the prime conductor, having acquired its full charge, suddenly strikes into the ball, A, of the first metallic stand, placed for that purpose at the striking distance. The explosion being made, and the prime conductor suddenly robbed of its elastic atmosphere, its pressure or action on the second conductor, and on the insulated person, as suddenly ceases, and the latter instantly feels a smart returning stroke, though he has no direct or visible communication (except by the floor) with either of the two bodies, and is placed at the distance of five or six feet from both of them. This returning stroke is evidently occasioned by the sudden re-entrance of the electric fire naturally belonging to his body and to the second conductor, which had before been expelled from them by the action of the charged prime conductor upon them; and which returns to its former place in the instant when that action or elastic pressure ceases. When the second conductor and the insulated person are placed in the densest part of the electrical atmosphere of the prime conductor, or just beyond the striking distance, the effects are still more considerable; the returning stroke being extremely severe and pungent, and appearing considerably sharper than even the main stroke itself received directly from the prime conductor. Lord Mahon observes, that persons and animals may be destroyed, and particular parts of buildings may be much damaged, by an electrical returning stroke, occasioned even by some very distant explosion from a thunder cloud; possibly at the distance of a mile or more. It is certainly not difficult to conceive, that a charged extensive thunder cloud must be productive of effects similar to those produced by the prime conductor; but perhaps the effects are not so great, nor the danger so terrible, as it seems to have been apprehended. If the quantity of electric fluid naturally contained, for example, in the body of a man, were immense or indefinite, then the estimate between the effects producable by a cloud, and those caused by a prime conductor, might be admitted; but surely no electrical cloud can expel from a body more than the natural quantity of electricity which this contains. On the sudden removal, therefore, of the pressure by which this natural quantity had been expelled, in consequence of the explosion of the cloud into the earth, no more (at the utmost) than his whole natural stock of electricity can re-enter his body, provided it be so situated, that the returning fire of other bodies must necessarily pass through his body. But perhaps we have no reason to suppose, that this quantity is so great, as that its sudden re-entrance into his body should destroy or injure him. See "Mahon's Electricity."

RETZIA, in botany, so named in honour of Anders Jahan Retzius, Professor of Natural History; a genus of the *Pentandria Monogynia* class and order. Natural order of Campanaceæ. Convolvuli, Jussieu. Essential character: corolla cylindrical, villose on the outside; stigma bifid; capsule two-celled, many-seeded. There is but one species, viz. R. spicata; it is found on the highest mountains, near the Cape of Good Hope.

REVENUE, *public*, the portion of the general income of a state, which is appropriated to the payment of national expenses. Different nations have adopted different modes of raising a public revenue, but the rent derived from land being obviously a fund of a more permanent nature than most others, has usually been one of the earliest resources, and has sometimes been the principal source of public revenue, particularly in ancient times. From the produce or rent of the public lands, the republics of Greece and Italy derived, for a long time, the greater part of the revenue which defrayed the necessary expenses of the commonwealth; and the rent of the crown-lands constituted the greater part of the revenue of the ancient sovereigns of Europe. The introduction of a different mode of warfare, and the greater duration of modern wars, increased considerably the public expenditure, and rendered it necessary to raise a much greater revenue. In the ancient republics of Greece and Italy, every citizen was a soldier, who both prepared himself for service, and served at his

own expense; and in the ancient monarchies of Europe, the people, when they served in the field, were, by the condition of their feudal tenures, to be maintained, either at their own expense, or at that of their immediate lords, without bringing any new charge upon the sovereign. The other necessary expenses of government were very moderate. The administration of justice, instead of being a cause of expense, was a source of revenue. The labour of the country people, for three days before and after harvest, was thought a sufficient provision for maintaining all the bridges, highways, and other public works, which the commerce of the country was supposed to require. In those days, the principal expense of the sovereign seems to have consisted in the maintenance of his own family and household. The officers of his household, accordingly, were then the great officers of state. The Lord Treasurer received his rents; the Lord Steward and Lord Chamberlain looked after the expense of his family; the care of his stables was committed to the Lord Constable and the Lord Marshal; his houses were all built in the form of castles, and the keepers of those houses or castles might be considered as a sort of military governors, who seem to have been the only military officers it was necessary to maintain in time of peace. In these circumstances, the rent of a considerable landed estate might, upon ordinary occasions, very well defray all the usual expenses of government, and whenever extraordinary circumstances caused a greater expense, the sum necessary to make it good was drawn from the people by some arbitrary and often very unequal imposition.

The ordinary revenue of the early kings of England, consisted of the following branches:

1. Rents and profits of the crown-lands. This must have been considerable, as it appears from Domesday-book, that there were appropriated to the use of the crown 1422 manors, besides other lands and quit-rents. This ancient branch of the King's revenue has, however, of late years become of very small amount, as the lands originally reserved by the crown, or which came to it afterwards by forfeiture, have been almost entirely granted away.

2. Profits from military tenures. As a great part of the lands in England were subject to knight-service, the profits incident to this tenure were very great, besides the extraordinary contributions to which they were liable, for making the King's eldest son a knight, and for marrying his eldest daughter.

3. The custody of the lay-revenues, lands, and tenements of bishoprics, during their vacancy; and, before the dissolution of abbeys, the custody of the temporalities of such as were of royal foundation. Many of the kings were induced to keep the sees a long time vacant in order to enjoy their temporalities.

4. First-fruits and tenths of all spiritual preferments. The former was the whole of the first year's produce of the preferment, according to a valuation made in 38 Henry III. and afterwards increased in 20 Edward II. The tenths were the tenth part of the whole annual profit of each living, by the same valuation. These revenues were paid to the Pope, till annexed to the crown by 26 Henry VIII. c. 3, when a new valuation was made, by which the clergy are at present rated, and which forms what is commonly called the King's Books. These revenues are now vested in trustees for ever, as a fund for the augmentation of poor livings, and form what is usually called Queen Ann's Bounty.

5. Purveyance and pre-emption, or a right of buying up provisions and other necessaries, for the use of the royal household, at an appraised valuation, in preference to all other persons, and even without the consent of the owner; also of forcibly impressing carriages and horses for the King's use, at a settled price. The purveyors greatly abused their authority, and were of little advantage to the crown; Charles II. therefore, at his restoration, agreed to resign this prerogative, with the military tenures; and the Parliament, in lieu thereof, settled on him and his successors for ever, a tax on beer and ale, afterwards commonly called the hereditary excise.

6. Fines and forfeitures of various descriptions; also fees to the crown, in a variety of legal matters.

7. The right to all shipwrecks; to treasure-trove; to royal fish, that is, whales and sturgeons, when thrown ashore, or caught near the coast; to all mines of silver or gold; to waifs, or goods stolen and thrown away by the thief in his flight; and estrays, or animals found wandering, and the owner unknown; and to deodands, and forfeitures of lands and goods for offences. These rights producing little profit, have since

been mostly granted away to the lords of manors and other liberties.

8. Escheats of lands, upon the defect of heirs to succeed to the inheritance, in which case they reverted to the King.

9. The custody of idiots and lunatics, the profits of whose lands were received by the King, an allowance being made to them for necessaries.

From these sources, the produce of the remaining branches of which is now very insignificant, the Kings of England derived the whole of their ordinary revenne, till commerce raised the produce of the customs into importance, and the Parliament ventured to grant the principal part of their produce to the King, for life. Upon extraordinary occasions, Henry II. and some of his successors, had recourse chiefly to scutages, which were a composition by those who held knight's fees, in lieu of the military service to which they were bound, and seem to have been at first mere arbitrary compositions, as the King and the persons liable could agree: hydage, and talliage, were taxes of the same nature, upon other lands, and upon cities and boroughs. Tenths and fifteenths were originally the real tenth or fifteenth of all the moveables belonging to the subject; the amount was uncertain, being levied by new assessments on every fresh grant, till the 8 Edward III. when a new assessment was made and recorded in the Exchequer, which was the real value at that period of every city, borough, and town in the kingdom, and by this the fifteenths were afterwards levied, according to the specific sums therein stated, which were usually raised in the different places by a common rate on all the inhabitants. Subsidies were a grant introduced about the time of Richard II. and Henry IV.; they were a tax not immediately imposed upon property, but upon persons in respect to their reputed estates, after the nominal rate of four shillings in the pound for lands, and two shillings and eightpence for goods; aliens paid in a double proportion. This assessment was made according to an ancient valuation, which was so low, that one subsidy, according to Sir Edward Coke, did not amount to more than 70,000*l.* It was the rule, never to grant more than one subsidy and two-fifteenths at a time; but this rule was broken through on the Spanish invasion in 1588, when the Parliament gave two subsidies and four-fifteenths. This mode of taxation fell into disuse during the civil wars in the reign of Charles I. when the Parliament introduced weekly and monthly assessments, at a fixed sum upon each county, which was levied by a pound rate, both upon lands and personal estates. The commonwealth afterward introduced excise duties, and derived some profit from the establishment of the post-office, both of which have been since improved into very productive sources of revenue.

At the period of the revolution, most of the ancient branches of the King's revenue had either been formally relinquished, or had greatly declined in their produce, and the parliamentary grants had for some years past consisted almost entirely of custom and excise-duties, with occasional poll-taxes and hearth-money. The total amount of the several branches of which the public revenue then consisted, will appear by the following statement, which was formed upon the average produce of four years.

Amount of the Public Revenue in 1688.

	£.	s.	d.
Subsidy of tonnage and poundage	577,507	12	10½
Hereditary and temporary excise	610,486	10	9
Hearth-money, about	200,000	0	0
Post Office, about	55,000	0	0
Duties on wines and vinegar	172,900	11	8½
Duties on tobacco and sugar	148,861	8	0
Duties on French linens, brandies, &c	93,710	8	1
Wine licences, seizures, &c	56,969	4	4
Total	£1,915,435	15	9

This was the whole of the public revenue, except the small duties of ten shillings per ton on wine, &c. first granted in 1666, and appropriated for defraying the expenses of coinage; and a duty of eighteen-pence per chaldron on coals, appropriated for com-

pleting St. Paul's church. This revenue, small as it now appears, must have been at least fully adequate to all the national expenses, if an account laid before the Parliament is to be depended upon, according to which the annual expenditure of James II. amounted, at a medium, to only 1,609,365*l.* 2*s.* 9*d.*

The heavy expenses incurred during the reign of William III. and the introduction of the funding system, caused a variety of new taxes to be imposed, and considerable additions to be made to those which previously existed. The hearth-tax was abolished, and the land-tax was levied by a new assessment, which has continued ever since. The malt-tax, the tax on hawkers and pedlars, on hackney-coaches, with many other new taxes, were introduced, which, with the augmentation of the customs and excise, raised the total amount of the public revenue, at the death of King William, to about double its amount at his accession. During the succeeding reigns, an almost infinite number of taxes have been imposed, in order to render the revenue adequate to the payment of the interest on the great accumulation of public debt, and to support a constantly increasing expenditure. The produce of different duties formerly constituted separate funds, appropriated to specific purposes; thus the several taxes which were rendered perpetual by 3 George I. c. 7, formed a fund called the general fund, distinct from the aggregate fund, and South Sea fund, before established; but of late years, the whole produce of all the branches of the public revenue has been brought into one fund, called the consolidated fund.

The various duties constituting the total public revenue of Great Britain, are arranged under the following heads:

1. The Customs, which consist of duties on goods imported, on goods exported, on goods carried coastways, and a tonnage duty. The total gross produce of this branch of the revenue, in the year ending 5th January, 1808, was 12,638,985*l.* 0*s.* 5¼*d.* which being subject to various deductions for drawbacks, bounties, charges of management, &c. rendered the net produce, applicable to national purposes, 10,193,172*l.* 19*s.* 5¼*d.*

2. The Excise, which consists principally of duties on malt, and malt-liquors of every kind, including the distillery; many other articles are, however, likewise included, as candles, leather, soap, starch, tea, coffee, wine, tobacco, salt, glass, printed goods, and bricks and tiles. The total gross amount of this productive source of revenue, in the year ending 5th January, 1808, was 25,941,630*l.* 13*s.* 8¼*d.* which was reduced, by allowances, drawbacks, and charges of management, to 24,169,716*l.* 13*s.* 0¼*d.*

3. Stamp Duties, laid on deeds and documents of almost every description. This mode of taxation was introduced into England in the year 1671, and revived in 1694, when a particular set of commissioners were first appointed for managing these duties; the produce was at first of small amount, but new duties being imposed, to which numerous additions have been since made, it has gradually increased, and, in the year ending 5th January, 1808, the gross amount was 4,543,971*l.* 17*s.* 5¼*d.* This amount is subject to various deductions, as, the charges of management, discounts, and other parliamentary allowances, the cost of parchment and paper for the country distributors, an allowance to the two universities on almanacks, and other incidental expenses, which reduced the net produce to 4,458,738*l.* 14*s.* 0¼*d.*

4. Land and Assessed Taxes. The land tax for many years differed from all other branches of the public revenue (except the old malt duty) in being granted annually; it was however regularly continued from year to year, never being wholly taken off, but it varied with respect to the rate at which it was imposed, having been usually reduced during peace and increased again in time of war, to answer in part the increased expenditure. From 1776 to 1798 it was regularly continued at 4*s.* in the pound, at which rate it was supposed to produce 1,989,673*l.* 7*s.* 10¼*d.* for England, and 47,954*l.* 1*s.* 2*d.* for Scotland, making in the whole 2,037,627*l.* 9*s.* 0¼. ; there was however a constant deficiency, to the amount, at an average, of about 235,000*l.* per annum, varying according to the regularity with which the tax was collected, and the amount of the different charges to which it was liable. In 1799 a scheme was adopted for the redemption of the land tax, for which purpose an act was passed, making the tax perpetual; it was then offered for sale to the proprietors of the lands upon which it was charged, or, if they declined it, to any other person who chose to become a purchaser. The consideration to be given in either case was not to be in money, but in three per cent. stock; the object of the scheme being to absorb a large quantity of

floating stock, and thus facilitate the raising of new loans. It was estimated that this measure would transfer about eighty millions of stock to government, but the terms offered were by no means such as to induce a general approval of it, and the total amount of stock transferred for land-tax redeemed on the first of February 1808 was only 22,976,829*l.* 10*s.* 4*d.* of course a very considerable portion of the tax still remained unredeemed. The assessed taxes consist of the duties on houses, windows, servants, carriages, horses, and horse-dealers, dogs, hair powder, and armorial bearings. The gross produce of the land and assessed taxes, in the year ending January 5th, 1808, was 6,909,190*l.* 12*s.* 9½*d.* and as the balances in hand at the beginning of the year exceeded the charges of management and other payments, the total net amount applicable to national purposes was 7,073,550*l.* 10*s.* 8¼*d.*

5. The Post Office. King James I. originally erected a post office for the conveyance of letters to foreign parts, previously to which an establishment of this kind had existed for the conveyance of inland letters. Some improvements were made in the management of it during the time of the commonwealth, and soon after the restoration a new general post office was established, the revenue derived from which was at first of small amount, but has since gradually increased, both from the increase of commercial intercourse, and the additional rates of postage which have since been imposed. In 1715, the gross produce of the inland office was 145,227*l.* in the year 1744 it amounted to 198,226*l.* and the gross amount of both the inland and foreign offices to 235,492*l.* In 1764 it amounted to 281,535*l.* at which time an act was passed for preventing abuses of the privilege of franking, which, with a further restriction at a subsequent period, has considerably improved this source of revenue. The total gross produce for the year, ending January 5th, 1808, was 1,495,490*l.* 11*s.* 9*d.* and the net produce 1,277,538*l.* 11*s.* 4¼*d.*

6. Sixpence in the pound on pensions and salaries. This deduction originated from a debt of the civil list in the reign of George I. To satisfy this debt an act was passed for raising half a million at five per cent. interest, to be charged upon a deduction of sixpence in the pound on all salaries, fees, and wages, payable in respect of offices of profit granted or derived from the crown. About three years after it was found necessary to raise half a million more for the same purpose, and the former sum bearing five per cent. interest was then paid off, the whole sum of 1,000,000*l.* being raised by way of lottery at an interest of three per cent. per annum. This debt is now charged on the consolidated fund, and consequently the duty established for the payment of its interest forms part of the income of the fund. The gross produce for the year ending the 5th of January 1808, was 72,207*l.* 12*s.* 2¼*d.* and the nett produce 71,353*l.* 0*s.* 5¼*d.*

7. One shilling in the pound on pensions and salaries. This is a duty of a similar nature with the foregoing, and was first imposed by 31 George II. c. 22. It extends to all salaries, fees, and perquisites, pensions, or gratuities payable out of any revenue belonging to his Majesty in Great Britain, exceeding the value of 100*l.* a year. Its gross amount in the year ending the fifth of January 1808 was 61,057*l.* 2*s.* 1*d.* and including a balance in hand at the beginning of the year, the nett amount was 62,685*l.* 5*s.* 8*d.*

8. Hackney coaches. In 1694 the licence of hackney coaches first became a branch of the public revenue. It has increased, both from the number licensed being greater than formerly, and from the duty imposed upon them having been raised very considerably, but it can never become of much importance ; it produced in the year ending the 5th of January 1808, 28,751*l.* 15*s.* gross, and 26,455*l.* 2*s.* 5¼. nett.

9. Hawkers and pedlars. In the year 1697 these itinerant merchants were first made subject to a particular tax, which could never be of much consequence as an object of revenue, and will probably fall off as new towns and villages are built in different parts of the country. The gross amount in the year ending the 5th of January 1808 was 13,231*l.* 0*s.* 4*d.* the nett produce 10,325*l.* 9*s.* 5*d.*

In addition to these several branches of the public revenue, there are some small branches of the old hereditary revenue still remaining. These consist chiefly of alienation fines, post fines, seizures of uncustomed and prohibited goods, compositions, profers, and the crown lands, of which the last is by far the most important.

Total nett Produce of the Permanent and Annual Taxes constituting the Ordinary Public Revenue of Great Britain, and of the additional Taxes imposed during the continuance of War, for one Year, ending the 5th of January, 1808.

ORDINARY REVENUES.	Nett Produce applicable to National Objects, and to Payments into the Exchequer. £.	s.	d.	Expense per cent. of collecting the nett Produce. £.	s.	d.
Customs	7,462,380	4	10¾	7	16	11
Excise (including the annual duties)	17,896,145	14	2	3	7	3
Stamps	4,458,738	14	0¼	2	18	5
Land and Assessed Taxes	7,073,530	10	8¾	4	0	4
Post Office	1,277,538	11	4½	29	2	9
6*d*. in the Pound on Pensions, &c.	71,353	0	5¼	0	12	9
1*s*. in the Pound on Pensions, &c.	62,685	5	8	0	13	11
Hackney Coaches	26,455	-	5¼	9	19	4
Hawkers and Pedlars	10,325	9	5	29	17	9
Small branches of the Hereditary Revenue	91,422	14	7¼			
Permanent and Annual Duties	38,430,575	7	10			
WAR TAXES.						
Customs	2,730,792	14	6¼			
Excise	6,273,570	18	10½			
Property Tax	9,864,189	4	10			
Arrears of Income Duty	23,072	19	0			
Arrears under Aid and Contribution Act	2,888	11	2¼			
Total Revenue £.	57,325,089	16	3¼			

Notwithstanding the sum annually drawn from the public in taxes has been raised to the above vast amount, it is still thought necessary to have recourse to the profit of lotteries, which, with the permanent and annual duties above stated, and a few small incidental receipts, forms the total public income in time of peace. In years of war, it is almost invariably found necessary to raise a large additional sum by way of loan, which, being added to the debt previously existing, it becomes necessary to augment the revenue appropriated to the payment of the interest thereon by the imposition of new taxes.

The nett produce of the several branches, after the payment of certain bounties, pensions, and other charges, is paid into the Exchequer to be applied to the services to which it is appropriated. The public accounts at the Exchequer, both of the revenue and expenditure, were, till within a few years, kept in a peculiar character in use no where else, and which, in the course of time, had become so unintelligible, even to the officers themselves, that it was usual to write all high numbers in common figures under the characters. It is a curious circumstance, that this obscure species of arithmetic was defective in having no characters to express high numbers, as millions, so far were the framers of it from having any idea of the amount to which the public revenue was to be extended.

REVERBERATION, in chemistry, denotes a kind of circulation of the flame by means of a reverberatory, or the return of the flame from the top of the furnace back to the bottom, chiefly used in calcination. Reverberation is of two kinds: the first with a close fire, that is, a reverberatory furnace, where the flame has no vent at top, being covered with a dome or capital, which repels its action back on the matter or the vessel that contains it, with increased vehemence. After this manner is refining, the distillation of acids, spirits, &c. performed. Reverberation with an open fire is that performed in a furnace or reverberatory, whose registers are all open, used in calcination, &c. See next article.

REVERBERATORY, or REVERBERATING FURNACE, a chemical furnace built close all around, and covered at the top with a capital of brick or tiles, so as not to give any vent to the heat or flame, but to determine it to reverberate or turn back from the brick-work with new force upon the matter placed at bottom. When the fire has no vent or passage at top, it is

a whole reverberatory. When the middle of the capital is open, and only the sides close, so that there is only a half circulation of the flame, it is called an half reverberatory. The reverberatory furnace is chiefly used in the fusion and calcination of metals and minerals, and on other occasions where the most intense heat is required, as in assaying, &c. Whence it is also called the melting furnace, and assaying furnace.

REVERSION, a sum of money, estate, annuity, or any other kind of property, the possession of which is not to be obtained till after the expiration of a certain period of time, or till some event, as the failure of a life or lives, has happened. The present value of such property depends greatly on the current interest of money, for if money produced only three per cent. interest, a person giving 1000*l.* for a reversionary estate relinquishes an annuity of 30*l.*, but if he could make five per cent. interest of his money he gives up an annuity of 50*l.*, and consequently in the latter case he would expect a greater reversion than the former. The true value of a reversion therefore is that present sum which if improved at a given rate of interest, would at the period when the reversion comes into possession amount to its then actual value. This, with respect to sums receivable at the end of a certain number of years, is easily found by Table II. article INTEREST.

Thus, if a person is entitled to 500*l.* at the end of ten years, and wishes to know its present worth: the value of one pound to be received at the end of this term, is, by the Table 613913, which multiplied by 500 gives 306*l.* 19*s.* 1*d.* for the present value of the reversion. In a similar manner the present worth of the reversion of an annuity or estate after a certain number of years may be found by Table II. article ANNUITIES.

Example 1. What is the present value of an annuity of 21*l.* for the term of 30 years, but which is not to commence till the expiration of 7 years from the present time? The present value of an annuity of one pound for 30 years, is, by the Table 15,372451, which multiplied by 21 gives 322,8214; but as each payment of the annuity is to be received 7 years later than if it commenced immediately, this sum must be multiplied by the value of one pound to be received at the end of 7 years, or, .710681, which gives 229*l.* 8*s.* 5*d.* for the present worth of the reversion.

Example 2. What is the present worth of a perpetual annuity of 50*l.* to commence at the expiration of a lease of which 5 years are unexpired? The value of a perpetual annuity commencing immediately is, at 5 per cent. interest, 20 years purchase; the value of an annuity for 5 years is, by the Table, 4,329477; the latter subtracted from the former, and the remainder multiplied by 50, gives 783*l.* 10*s.* 6*d.* the value of the reversion.

Reversionary interests depending on a life or lives, particularly when several lives are concerned, form more intricate questions; but the cases which most commonly occur may be resolved by the following problems.

Problem 1. A sum of money is to be received at the death of a person, who is now of a given age; what is the value thereof in present money?

Subtract the value of the life from the perpetuity; then, as the perpetuity is to the remainder, so is the proposed sum to its value in present money.

Example. Let the age be 30 years, and the given sum 500*l.* Then the value of the life being 13,072 and the perpetuity 20, it will be, as 20 : 6,928 : : 500*l* : 173*l.* 4*s.* the value sought.

Problem 2. To find the value of the reversion of one life after another.

From the value of the life in expectation subtract the value of the two joint lives; the remainder will be the required value of the reversion.

Example. Let the age of the life in possession be 55 years, that of the life in expectation 20 years, and the annuity 100*l.* Then, by Table V. (article ANNUITIES) the value of the two joint lives will be 8,216, which subtracted from 14,007 the value of the life in expectation, leaves 5,791 years purchase for the value of the reversion; which multiplied by the annuity, gives 579*l.* 2*s.* its value in present money.

Problem 3. To find the value of the reversion of two lives after one.

From the value of the longest of the three lives subtract the value of the life in possession, the remainder will be the value of the reversion.

Example. Let the age of the life in possession be 40 years, and the ages of the two lives in expectation be 20 and 65 years; in this case, the value of the three lives being 15,902, and that of the life in possession 11,837, the answer will be 4,065 years purchase: so that, if the annuity was to be 500*l.* the value of the reversion would be 2032*l.* 10*s.*

Problem 4. To find the value of an annuity certain for a given term after the extinction of any given life or lives.

Subtract the value of the life or lives from the perpetuity, and reserve the remainder: then say, as the perpetuity is to the present value of the annuity certain, so is the said reserved remainder to a fourth proportional, which will be the number of years purchase required.

Example. Suppose A and his heirs are entitled to an annuity certain for 14 years, to commence at the death of B, aged 25.—What is the present value of A's interest in this annuity?—The value of the life of B is 13,567 which subtracted from 20 (the perpetuity) leaves 6,433 for the remainder: therefore, as 20 is to 9,198 the value of an annuity certain for 14 years, so is 6,433 to 3,183 the number of years purchase required.

Problem 5. B, who is of a given age, will, if he lives till the decease of A, whose age is also given, become possessed of an estate of a given value; what is the worth of his expectation in present money?

Find the value of an annuity on two equal joint lives whose common age is equal to the age of the oldest of the two proposed lives, which value subtract from the perpetuity, and take half the remainder; then say, as the expectation of duration of the younger of the two lives is to that of the older, so is the said half remainder to a fourth proportional; which will be the number of years purchase required when the life of B in expectation is the older of the two; but if B be the younger, then add the value so found to that of the joint lives A and B, and let the sum be subtracted from the perpetuity, which gives the answer in this case.

Example 1. Suppose the age of A to be 20, and that of B 30 years; and the annual value of the estate 50*l.* Then the value of two equal joint lives aged 30 being 10,255, and the perpetuity 20, the difference will be 9,745, the half of which is 4,872. Therefore, as 33,43, the expectation of A, is to 28,27 the expectation of B, so is 4,872 to 4,119 years purchase, which being multiplied by 50, the given annual value, we have 205*l.* 19*s.* for the required value of B's expectation.

Example 2. Let the age of A be 30, that of B 20 years; and the rest as in the preceding example. Then, the value of the joint lives is 10,707, which being added to 4,119 found above, the sum is 14,826; and this subtracted from 20 the perpetuity, and multiplied by 50, gives 258*l.* 14*s.* for the value in this case.

Problem 6. To find the value of a given estate at the death of B, provided that should happen after the death of A.

Find the value of an annuity upon the longest of two equal lives whose common age is that of the older of the two lives, A and B, which value subtract from the perpetuity and take half the remainder. Then, as the expectation of duration of the younger of the lives is to that of the older, so is the said half remainder to the number of years purchase required, when B is the older of the two. But if B be the younger, then to the number of years purchase thus found add the value of an annuity on the longest of the lives, A and B, and subtract the sum from the perpetuity for the answer in this case.

Example 1. Let the age of A be 30, and that of B 60 years; the given estate 120*l.* per annum. Then the value of an annuity on the longest of two lives aged 60 each, will be found to be 10,896, which taken from 20 the perpetuity, leaves 9,104 for the remainder. Therefore it will be as 28,27, the expectation of A, is to 13,21 the expectation of B, so is 4,552 the half remainder, to 2,127 the number of years purchase required, which, being multiplied by 120, gives 255*l.* 4*s.* 9*d.* for the present value.

Example 2. Let the age of A be 60 and that of B 30 years; then, to the number of years purchase found in the preceding example, add 14,172 the value of an annuity on the longest of the two lives, the sum is 16,299, and this subtracted from 20 the perpetuity, and multiplied by 120, gives 444*l.* 2*s.* 4*d.* for the value in this case.

The solutions of the two last problems comprehend all the cases of survivorship between two lives for their whole duration; but an expectation dependent on survivorship is sometimes restricted to a term of years less than the whole duration of the lives. Those who have occasion for the rules for resolving questions of this description, or of the various cases which may arise when three or more lives are concerned, are referred to Mr. T. Simpson's Doctrine of Annuities, Dr. Price's Treatise on Reversionary Payments, or Mr. W. Morgan's Treatise on Annuities and Assurances.

Reversionary interests being a species of property of which purchasers are not always readily found, those who have occasion to

dispose of an interest of this kind generally sell it by public auction, in which mode it very seldom happens that more than two-thirds of the true calculated value is obtained.

REVERSION *of series*, in algebra, a kind of reversed operation of an infinite series.

REVERSION, in law, is that part of an estate, or interest, which remains to the original grantor, or his heirs, after the particular or less estate which he has granted shall expire. Thus, if A having the fee, grant an estate for life, or in tail, to B, A still has an estate in fee, in reversion, expectant upon the failure or determination of the particular estate of B. It differs from a remainder, in being the remnant of the estate in the hands of the original grantor; but a remainder is something granted out by the grantor. See REMAINDER.

REVIEW. In the military acceptation of the term, an inspection of the appearance, and regular disposition of a body of troops, assembled for that purpose. At all reviews, the officers should be properly armed, ready in their exercise, salute well, in good time, and with a good air; their uniform genteel, &c. The men should be clean and well dressed; their accoutrements well put on; very well sized in the ranks; the serjeants expert in their duty, drummers perfect in their beatings, and the fifers play correct. The manual exercise must be performed in good time, and with life; and the men carry their arms well; march, wheel, and form with exactness. All manœuvres must be performed with the utmost regularity, both in quick and slow time. The intention of a review is, to know the condition of the troops, to see that they are complete, and perform their exercise and evolutions well.

REVIEW, *bill of*, in chancery, is where a cause has been heard, and the decree signed and enrolled; and some error in law appears upon the decree, or new matter is discovered in time after the decree made, a bill of review is then had.

REVISE. See PRINTING.

REVIVOR, *bill of*, is where a bill has been exhibited in Chancery against one who answers, and before the cause is heard, or if heard, before the decree enrolled, either party dies. The cause is then said to die also, and a bill of revivor must be brought, that the former proceedings may stand revived, and the cause be finally determined.

REVOCATION, in law, a destroying or making void a deed or will which existed before the act of revocation.

Some things may be revoked, of course, though they are made irrevocable by express words; as a letter of attorney, a submission to an award, and a testament, or last will.

By the statute of frauds, 29 Charles II. c. 3. no devise of lands shall be revocable, otherwise than by some other will, or codicil, in writing, or other writing declaring the same, signed in the presence of three witnesses. But still such a devise may be revoked by destroying the will, or by any other revocation by act of law; such as granting away the estate to another, by deed.

REVOLUTION, in astronomy, is the period of a planet or comet, &c. or its course from any point of its orbit till it return to the same again. Planets have a twofold revolution: one about their axis, called their diurnal rotation, which constitutes their day; the other, about the Sun, called their annual revolution, constituting their year.

REVOLUTION, in geometry, the motion of rotation of a line about a fixed point or centre, or of any figure about a fixed axis, or upon any line or surface. Thus the revolution of a given line about a fixed centre, generates a circle; and that of a right-angled triangle about one side, as an axis generates a cone; and that of a semicircle about its diameter generates a sphere or globe.

RHABDOLOGY, in arithmetic, the doctrine of Neper's rods. See NEPER.

RHAMNUS, in botany, *buck-thorn*, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ Rhamni, Jussieu. Essential character: calyx tubular; corolla scales defending the stamens inserted into the calyx; berry. There are forty-two species.

RHAPIS, in botany, a genus of the Appendix Palmæ. Natural order of Palmæ. Essential character: calyx trifid; corolla trifid; stamens six; pistil one. There are two species, viz. R. flabelliformis, creeping rooted rhapis, or ground rotan; and R. arundinacea, simple-leaved rhapis.

RHEEDIA, in botany, so named in memory of Henry Rheede Van Draakenstein, a genus of the Polyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx none, corolla four-petalled; berry three-sided.

There is but one species, viz. R. lateriflora.

RHETICUS (George Joachim), in biography, a noted German astronomer and mathematician, was born at Feldkirk, in Tyrol, the 15th of February, 1514. After imbibing the elements of the mathematics at Tiguri, with Oswald Mycone, he went to Wittemberg, where he diligently cultivated that science. Here he was made master of philosophy in 1535, and professor in 1537. He quitted this situation, however, two years after, and went to Fruenberg to put himself under the assistance of the celebrated Copernicus, being induced to this step by his zeal for astronomical pursuits, and the great fame which Copernicus had then acquired. Rheticus assisted this astronomer for some years, and constantly exhorted him to perfect his work, De Revolutionibus, which he published after the death of Copernicus, viz. in 1543, folio, at Norimberg, together with an illustration of the same in a narration, dedicated to Schoner. Here too, to render astronomical calculations more accurate, he began his very elaborate canon of sines, tangents, and secants, to fifteen places of figures, and to every ten seconds of the quadrant, a design which he did not live quite to complete. The canon of sines, however, to that radius, for every ten seconds, and for every single second in the first and last degree of the quadrant, computed by him, was published in folio, at Franckfort, 1613, by Pitiscus, who himself added a few of the first sines computed to twenty-two places of figures. But the larger work, or canon of sines, tangents, and secants, to every ten seconds, was perfected and published after his death, viz. in 1596, by his disciple, Valentine Otho, mathematician to the Electoral Prince Palatine.

After the death of Copernicus, Rheticus returned to Wittemberg, viz. in 1541 or 1542, and was again admitted to his office of professor of mathematics. The same year, by the recommendation of Melancthon, he went to Norimberg, where he found certain manuscripts of Werner and Regiomontanus. He afterwards taught mathematics at Leipsic. From Saxony he departed a second time, for what reason is not known, and went to Poland; and from thence to Cassovia, in Hungary, where he died December the 4th, 15'6, near sixty-three years of age.

His Narratio de libris Revolutionum Copernici, was first published at Gedanum, in quarto, 1540, and afterwards added to the editions of Copernicus's work. He also composed and published Ephemerides, according to the doctrine of Copernicus, till the year 1551.

Rheticus also projected other works, and partly executed them, though they were never published, of various kinds, astronomical, astrological, geographical, chemical, &c. as they are more particularly mentioned in his letter to Peter Ramus, in the year 1568, which Adrian Romanus inserted in the preface to the first part of his idea of mathematics.

RHETORIC, from the Greek word ῥέω, to speak, may be defined the art of speaking with persuasion.

This art, like all others, is the result of observations and experiments made by men of good capacities and of enlightened minds. After multiplied and often defective essays, those principles are at length discovered, which distinguish between the good and the bad, between the faulty and the perfect. These principles, when reduced to method, and well arranged, save succeeding enquirers much pains and trouble, considerably shorten the road to knowledge, and materially assist in the formation of a correct judgment. As in respect to poetry, it is contended, that though accurate rules of criticism will not bestow genius, they will check redundancy and bombast, and detect all the errors into which the competitors for the laurel are too apt to be betrayed, so with regard to the precepts of rhetoric it may safely be asserted, that though they will not generate that energy of mind which rises to the highest flights of eloquence, they will effectually warn the orator against incongruity in the disposition of his matter, absurdity in argument, and the false glitter of ornament which amuses instead of convincing, or those injudicious attempts to interest the feelings which excite ridicule rather than sympathy.

This will be the more manifest if we consider that the foundation of eloquence is right reason, and that its exercise implies the possession of that faculty both in the speaker and the hearer. It was well observed by the Stagyrite, that rhetoric is nearly allied to logic.

In displaying the utility of the art of rhetoric Quintilian expresses himself in the following forcible terms; "If in any thing the Creator has distinguished us from the rest of the animals, it is by the gift of speech. They surpass us in strength, in pati-

ence, in size, in swiftness, and especially in independence of foreign aid. Guided by instinct, they soon learn by its instructions to walk, to feed themselves, and to swim. Their protection against the cold, and their weapons of defence, are provided for them by nature. But what pains and labour does it cost man to procure all these things. Reason is our inheritance, and seems to associate us to immortal beings. But how feeble would reason be were it not for the faculty of expressing our thoughts by speech, which is the faithful interpreter of reason. This is what is wanting to the inferior animals much more than understanding, of which it cannot be justly said that they are absolutely destitute. If then we have received nothing from the Deity better than the use of speech, what is there which we ought to cultivate with greater industry? What object is more worthy of our ambition than that of rising above other men by that faculty, which alone raises them above the level of the brutes."

A still greater dignity will attach to the acquirement of eloquence, and consequently to the science of rhetoric, if it be considered that eloquence and freedom go hand in hand. It is in free states, and under popular governments alone, that oratory can flourish. When the people are appealed to on the subject of state affairs; when political measures are to be enforced by the enlightening of their judgment, or by the excitement of their passions, the greatest talents are exercised in studying the art of persuasion, and the result is found in the most wonderful efforts of human ability. But when brute force predominates, and the people bow beneath the yoke of tyranny, the voice of reason is stilled, and eloquence is mute.

The ancient rhetoricians distinguish oratorical composition into three species; *viz.* the demonstrative, the deliberative, and the judicial.

The first of those species is chiefly conversant in bestowing praise or blame, and comprehends in its definition the panegyric and the funeral eulogy, which were so much in use among the ancients. In the former class may be enumerated Isocrates's Panegyric on Evagoras King of Salamis, Cicero's Oration on the pardoning of Marcellus, his Philippics against Mark Antony, and Pliny's Panegyric on Trajan. Of the latter, specimens may be found in the funeral orations composed by Thucydides and Plato to commemorate the virtues of the Athenians who fell at the commencement of the Peloponnesian war. Nor have the moderns been wanting in excellent specimens of this species of eloquence. The funeral discourses of the most celebrated French and English preachers, the *éloges* pronounced upon eminent men before the French Academy, the generality of modern pulpit compositions, and the occasional commendatory or vituperative speeches which have at various times been uttered in the British Parliament, will afford rich subjects of study to him who wishes to become acquainted with the principles of demonstrative eloquence.

Deliberative eloquence comprehends a most extensive field, embracing as its object the whole extent of public affairs; such, for instance, as war and peace, political negociations, domestic interests, foreign alliances, the regulation of trade and commerce, and in general all matters connected with legislation and government. This species of eloquence cannot be cultivated in any other than a free state. The will of an arbitrary monarch supersedes its use, or terrifies it to silence. It is therefore to the "high and palmy state" of Athens and of Rome that we must look for its energies as exhibited in ancient times, and we shall find its proudest memorials in the works of Demosthenes and Cicero. In more modern times it has, by the operation of political causes, been almost exclusively confined to the limits of our own island. And whilst the parliamentary speeches of Chatham, of Burke, of Fox, and of Pitt, remain upon record, Britain may dispute the meed of deliberative eloquence with either of the haughty republics of antiquity.

Judicial eloquence comprehends in its purview the whole extent of judicial proceedings, both civil and criminal; that is to say, the attack and defence of persons and of property. In ancient times the business of judicial pleading was not confined to one class of men. The Roman orator was at all times ready to impeach a state criminal, or to plead in defence of the life, the honour, or the fortune of his friend. These were the illustrious days of forensic eloquence, when the first characters of the republic displayed their abilities at the bar; when Cicero and Hortensius, in amicable rivalry, gave full scope to their superlative talents. But degraded as the profession of an advocate is now in some respects acknowledged to be, yet in the proceedings of a British court of justice, there have for a long series of years been evinced proofs of the most

searching sagacity, the soundest judgment, and the most ready wit.

In regular orations of every species there will generally be found the following subdivisions. The exordium, or introduction; the statement of the subject; the narrative, or explanation; the reasoning, or argument; the pathetic part; and, lastly, the peroration, or conclusion.

The object of the exordium is to conciliate the good will of the hearers, to awake their attention, and to render them open to persuasion. The topics by which these purposes may best be effected will suggest themselves to the good sense of the speaker, as arising from the character and peculiar prejudices of his auditors, from his own relative situation, from the peculiar circumstances of the times, or from the nature of his cause.

In the proposition of the subject, the qualities chiefly to be aimed at are clearness and distinctness. These qualities are indeed of the most essential importance, and the attainment of them is well worth the utmost care and pains. In debates of every kind, that speaker is listened to with the greatest pleasure, who is able briefly and plainly to give the most accurate account of the points principally in question.

As the narrative, or explanation of facts, is to be the ground-work of all the future reasonings of the orator, it is obviously his duty to recount them in such a manner as may be most favourable to his cause; to place in the most striking light every circumstance which is to his advantage, and to soften such as make against him. He must also exercise consummate judgment, so that his narration may be at once concise and full, copious and distinct. In short, a perfect narration is one from which nothing can be taken without rendering it obscure, and to which nothing can be added without weakening its force.

In his arguments, a speaker should, as Quintilian expresses it, possess logic as a philosopher, and employ it as an orator. He should follow the lucid order of nature in their disposition, and express them in such a style and manner as to give them their full force. He should take care not to multiply them to too great an extent, and to bring into a conspicuous point of view those which are the most weighty and cogent.

In the pathetic part of his discourse, which generally introduces and pervades the peroration, the ancient orator collected all the might of his abilities to strike as it were a finishing stroke. But Quintilian, with his usual judgment, warns his pupil against dwelling upon this topic too long. "Time," says he, "soon calms real griefs; how much more easily must it dissipate the illusory impressions which act only upon the imagination. Let not then the pathetic strain be too long continued. If this precept be not well observed, the auditor is fatigued; he resumes his tranquillity, and recovering from the transitory emotion, he returns under the influence of reason. We ought not, then, to suffer his feelings to cool; and when we have carried them as far as they can go, we ought to stop, and not to deceive ourselves with the idea, that the mind will for any long space of time be sensible to emotions which are foreign to it."

When Roman eloquence was in its most flourishing state, this oratorical subdivision was an object of assiduous study; and in order to excite the feelings of the audience, the orator had frequent recourse to sensible objects. The weeping relatives of the defendant, the wounds which an accused person had received in fighting the battles of his country, a dagger, or a bloody robe: these exhibitions were frequently resorted to, in order to excite compassion, or to rouse indignation. They are, however, so inconsistent with modern usages, and especially with the cool and phegmatic temperament of our countrymen, that the most consummate prudence and skill can alone adopt any of them with effect. Where a Burke has failed, he must be a bold man who would repeat the experiment.

The precise nature of the conclusion of any discourse must be determined in a great measure by the nature of that discourse, and the circumstances in which it is delivered. Sometimes it may be expedient to compress in it a repetition of the substance of a long train of antecedent argument; on some occasions it should assume the humble tone of pathos, and on others it should rise into the dignity of confidence: but in all cases, as Dr. Blair properly remarks, "it is a matter of importance to bring our discourse just to a point; neither ending abruptly and unexpectedly, nor disappointing the hearers, when they look for the close, and continuing to hover round the conclusion till they become heartily tired of us. We should endeavour to go off with a good grace; not to end with a languishing and drawling sentence; but to close

with dignity and spirit, that we may leave the minds of the hearers warm, and dismiss them with a favourable impression of the subject and of the speaker."

RHEUM, in botany, *rhubarb*, a genus of the Enneandria Trigynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx none; corolla six-cleft, permanent; seed one, three-sided. There are seven species, among which we shall notice the R. palmatum, officinal rhubarb: the root is perennial, thick, of an oval shape, sending off long tapering branches; externally it is brown, internally of a deep yellow colour; stem erect, round, hollow, jointed, from six to eight feet in height; root leaves numerous, large, rough, of a roundish figure, deeply cut into lobes and irregularly pointed segments; on long foot-stalks; stem leaves one at each joint, from a membranaceous sheath, successively smaller upwards; flowers surrounding the branches in numerous clusters, forming a kind of spike; corolla of a greenish white colour. It is a native of China and Tartary. At the end of six or seven years, when the plant seems to arrive at its most perfect state, one pound of rhubarb may be obtained from every five pounds of the green roots, besides an equal or larger proportion of roots fit for family use.

RHEXIA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Melastomæ, Jussieu. Essential character: calyx four-cleft; petals four, inserted into the calyx; anthers declining; capsule four-celled, within the belly of the calyx. There are thirteen species: all these plants are found wild in America.

RHINANTHUS, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx four-cleft, ventricose; capsule two-celled, blunt, compressed. There are eight species.

RHINOCEROS, in natural history, a genus of mammalia of the order Feræ. Generic character: horn solid, perennial, conical, seated on the nose, but not adhering to the bone. This quadruped is exceeded in size only by the elephant. Its usual length, not including the tail, is twelve feet; and the circumference of its body nearly the same. Its nose is armed with a horny substance, projecting, in the full-grown animal, nearly three feet, and is a weapon of defence, which almost secures it from every attack. Even the tiger, with all his ferocity, is but very rarely daring enough to assail the rhinoceros. Its upper lip is of considerable length and pliability, acting like a species of snout, grasping the shoots of trees and various substances, conveys them to the mouth, and it is capable of extension and contraction at the animal's convenience. The skin is, in some parts, so thick and hard as scarcely to be penetrable by the sharpest sabre, or even by a musket-ball. These animals are found in Bengal, Siam, China, and in several countries of Africa; but are far less numerous than the elephant, and of sequestered solitary habits. The female produces only one at a birth; and at the age of two years the horn is only an inch long, and at six, only of the length of nine inches. The rhinoceros is not ferocious unless when provoked, when he exhibits paroxysms of rage and madness, and is highly dangerous to those who encounter him. He runs with great swiftness, and rushes through brakes and woods with an energy to which every thing yields. It is generally, however, quiet and inoffensive. Its food consists entirely of vegetables, the tender branches of trees, and succulent herbage, of which it will devour immense quantities. It delights in retired and cool situations, near lakes and streams, and appears to derive one of the highest satisfactions from the practice of rolling and wallowing in mud; in this respect bearing a striking resemblance to the hog.

This animal was exhibited, by Augustus, to the Romans, and is supposed to be the unicorn of the scripture, as it possesses the properties ascribed to that animal of magnitude, strength, and swiftness, in addition to that peculiarity of a single horn, which may be considered as establishing their identity. This animal can distinguish, by its sight, only what is directly before it, and always, when pursued, takes the course immediately before him, almost without the slightest deviation from a right line, removing every impediment. Its sense of smelling is very acute, and also of hearing, and, on both these accounts, the hunters approach him against the wind. In general, they watch his lying down to sleep, when advancing with the greatest circumspection, they discharge their muskets into his belly. The flesh is eaten both in Africa and India.

R. bicornis, or the two-horned rhinoceros, is similar in size and manners to the former, and is principally distinguished from it by having two horns on its nose; the first being always the largest, and some-

a foot and a half in length. These substances are said to be loose when the animal reposes, or is calm, but to be fixed irremoveably when he is highly excited; a circumstance asserted by Dr. Sparrman, though ridiculed by Mr. Bruce. It is, however, observed by Dr. Shaw, that, on inspection of the horns and the skin on which they are seated, they do not appear firmly attached to the bone of the cranium. This animal, after having devoured the foliage of trees, rips up their trunks, and dividing them with his horns into a sort of laths, fills his immense jaws with these fruits of his labour, and masticates them with as much facility as an ox does grass. Its swiftness is great considering its bulk, but its security arises not so much from speed as from its directing its course to thickets and woods, where sapless trees are broken by its violence, and green ones after yielding to it, recoil upon the pursuers, and strike them from their horns sometimes with fatal consequences. In an open plain the horse speedily overtakes him, on which he makes a thrust with his horn at the horse, which the latter easily evades by its agility. A man at this moment drops from behind the chief horseman, with a spear, and, as the rhinoceros sees only immediately before him, wounds him in the tendons of his heels, and thus totally disables him from further motion. He is also occasionally taken by night while rolling himself in mire, in which he appears to experience a rapture which deprives him of all suspicion and vigilance; while thus abandoning himself to transport, the hunters approach and fix a mortal wound, by their spears or muskets, in his belly. See Mammalia, Plate XVIII. fig. 5.

RHINOMACER, in natural history, a genus of insects of the order Coleoptera. Antennæ setaceous, seated on the snout; four feelers, growing thicker towards the end, the last joint truncate. There are three species, found in Italy and Sweden.

RHIZOBOLUS, in botany, a genus of the Polyandria Tetragynia class and order. Essential character: calyx, half five-cleft; petals five; germ four-lobed, superior; nuts four, one-celled, one-seeded. There are two species, *viz.* R. butyrosus, and R. tuberculosus, both natives of Guiana.

RHIZOPHORA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Holoraceæ. Caprifolia, Jussieu. Essential character: calyx four-parted; corolla four-parted; seed one, very long, fleshy at the base. There are six species, of which R. mangle, or mangrove tree, commonly attains the height of fifty feet; it is generally found on the borders of the sea, in whose waters alone it seems to thrive, and there only in such places as have a soft and yielding bottom; its larger branches frequently emit soft and weakly appendicles, having the appearance of so many slender, leafless branches, always bending downwards; but as these are softer, and furnished each with a large column of a lax, spongy pith in the centre; they grow more luxuriantly than the other parts of the tree, and reach the mud in a short time, where they throw out a numberless series of slender fibres, which in time become roots, to supply the stem more copiously with nourishment, whilst they become so many props or limbs to the parent tree; the trunk seldom grows to any considerable thickness; the bark is excellent for tanning leather; it performs this operation more perfectly in six weeks, than oak bark will do in ten. The mangrove is a native both of the East and West Indies, of the Society and Friendly islands, the New Hebrides, and New Caledonia, in the South Seas.

RHODIOLA, in botany, a genus of the Dioecia Octandria class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: male, calyx four-parted; corolla four-petalled; nectary four: female, calyx four-parted; corolla four-petalled; nectary four; pistils four; capsules four, many-seeded. There are two species, *viz.* R. rosea, common, or yellow rose-wort. and R. bitternata.

RHODODENDRUM, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes. Rhododendra, Jussieu. Essential character: calyx five-parted; corolla funnel-form; stamina declined; capsule five-celled. There are nine species.

RHODORA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Rhododendra, Jussieu. Essential character: calyx five-toothed; petals three, unequal; stamina declined; capsule five-celled. There is only one species, *viz.* R. canadensis, a native of Newfoundland, from which place it was introduced by Sir Joseph Banks.

RHOEADEÆ, in botany, the name of the twenty-seventh order in Linnæus' Fragments of a Natural Method, consisting of the poppy, and a few genera which resemble it in habit and structure. The plants,

in this order, upon being cut, yield plentifully a juice which is white in the poppy, and yellow in others. See POPPY.

RHOMB *spar*, in mineralogy, a species of the Calx genus, of a greyish colour passing to yellow: it is never massive, but always in regular, middle-sized rhombs; the lustre is splendent, and between vitreous and pearly; it is brittle, easily frangible; specific gravity 2.5; it is infusible, without addition. With acids, it produces very little effervescence, even when pulverized. Constituent parts:

Carbonate of lime	52
Carbonate of magnesia	45
Oxide of iron and manganese	3
	100

It is found in Switzerland, Sweden, and in chlorite rocks, on the banks of Loch Lomond in Scotland.

RHOMBOIDES, in geometry, a quadrilateral figure, whose opposite sides and angles are equal, but is neither equilateral nor equiangular.

RHOMBUS, in geometry, an oblique-angled parallelogram, or a quadrilateral figure, whose sides are equal and parallel, but the angles unequal, two of the opposite ones being obtuse, and the other two acute. To find the area of a rhombus, upon the base, let fall the perpendicular, which is the altitude of the figure; then multiply the base by the altitude, the product will be the area.

RHUBARB. This is the root of the rheum palmatum, and perhaps also of some other species of rheum, brought chiefly from the northern parts of China, by the way of Russia, though of late it has been cultivated also in Britain. The root is large, of an oblong or roundish shape; of a dark-brown colour externally, with black and reddish streaks; internally it is reddish-yellow, and, when fresh, contains a juice of the same colour. No accurate chemical analysis of rhubarb has yet been made; but, from the experiments of Neumann, it appears that nearly one-half of it is soluble in water, and that alcohol scarcely takes up any thing from the residue. From the properties of the watery extract, enumerated by that laborious chemist, we may infer, with some probability, that it consists chiefly of an extractive and bitter principle, and that it contains some tannin. A small quantity of greenish-yellow, resinous matter, seems also to be present. Scheele separated from the root about one-sixth of its weight of oxalate of lime. But this salt is not taken up by water. See MATERIA MEDICA, and PHARMACY.

RHUMB, in navigation, a vertical circle of any given place, or the intersection of such a circle with the horizon; in which last sense rhumb is the same with a point of the compass.

RHUMB *line*, is also used for the line which a ship describes when sailing in the same collateral point of the compass, or oblique to the meridians.

RHUS, in botany, *sumach*, a genus of the Pentandria Trigynia class and order. Natural order of Dumosæ. Terebintaceæ, Jussieu. Essential character: calyx five-parted; petals five; berry one-seeded. There are thirty-four species.

RIBES, in botany, the *currant* and *gooseberry*, a genus of the Pentandria Monogynia class and order. Natural order of Pomaceæ. Cacti, Jussieu. Essential character: petals five, inserted with the stamens into the calyx; style bifid; berry many-seeded, inferior. There are seventeen species, *viz.* ten of the currant, and seven of the gooseberry; all these shrubs are too well known to need a particular description in this work.

RICCIA, in botany, so named in honour of Pietro Francisco Riccio; a genus of the Cryptogamia Hepaticæ class and order. Generic character: male, flowers sessile on the surface of the frond; calyx and corolla none: female, flowers on the same, or, according to Micheli, on a distinct plant; calyx none, except a vesicular cavity, within the substance of the leaf; corolla none. Linnæus has five species, natives of Europe. Withering reckons the same number, all natives of Britain.

RICHARDIA, in botany, so named from Richardson; a genus of the Hexandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx six-parted; corolla one-petalled, sub-cylindric; seeds three. There is only one species, *viz.* R. scabra, a native of Vera Cruz.

RICHERIA, in botany, so named in memory of Pierre Richer de Belleval, Professor of Botany, at Montpelier; a genus of the Dioecia Pentandria class and order. Essential character: capsule corticate, six-valved, three celled; seeds solitary, pendulous, below the tip of the columella; style trifid. There is but one spe-

cies, viz. R. grandis, a native of Montserrat.

RICINUS, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx five-parted; corolla none: male, stamens numerous: female, styles three, bifid; capsule three-celled; seed one. There are six species.

RICOTIA, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, or Cruciformes. Cruciferæ, Jussieu. Essential character: silique one-celled, oblong, compressed, with flat valves. There is but one species, viz. R. ægyptiaca, Egyptian ricotia.

RIDE, in the sea-language, is a term variously applied: thus, a ship is said to ride, when her anchors hold her fast, so that she does not drive by the force either of the wind or tide. A ship is said to ride across, when she rides with her fore and main yards hoisted up to the hounds, and both yards and arms topped alike. She is said to ride well, when she is built so as not to over-beat herself in a head-sea, the waves over-raking her from stem to stern. To ride athwart, is to ride with her side to the tide. To ride betwixt wind and tide, is to ride so as the wind has equal force over her one way, and the tide the contrary way. If the wind has more power over the ship than the tide, she is said to ride wind-road, or to ride a great wind. And she is said to ride a-portoise, when the yards of a ship are struck down upon the deck.

RIDER, is a schedule, or small piece of parchment, added to some part of a record; as when, on the third reading of a bill in Parliament, a new clause is added, that is tacked to the bill, on a separate piece of parchment, and is called a rider.

RIDING, *armed*, with dangerous and unusual weapons, is an offence at common law.

RIFLE, a fire-arm, which has the inside of its barrel cut with from three to nine or ten spiral grooves, so as to make it resemble a female screw, varying from a common screw only in this, that its grooves or rifles are less deflected, and approach more to a right line; it being now usual for the grooves with which the best-rifled barrels be cut, to take about one whole turn in a length of thirty inches. The number of the grooves differ according to the size of the barrel, and fancy of the workman; and their depth and width are not regulated by any invariable rule. The method of loading them is as follows: when the proper quantity of powder (one drachm avoirdupois) is put down at the muzzle, and a piece of calico, or linen, is gently rammed down over it as a wad, a circular piece of strong calico is greased on one side, and laid on the mouth of the piece, with the greased side downwards; and a bullet of the same size as the bore of the piece before the grooves were cut, being placed upon it, is then forced gently down the barrel with it; by which means, the calico incloses the lower half of the bullet; and, by its interposition between the bullet and the grooves, prevents the lead from being cut by them, and, by means of the grease, slides down, without its being necessary to use any violent efforts, which would destroy the circular shape of the bullet. In order to understand the cause of the superiority of a rifle-barrel gun over one with a smooth barrel, it will be necessary to refer to Mr. Robins's discovery of the cause of the irregularities which occur in the flight of projectiles from smooth barrels, which we shall give in his own words, "Tracts on Gunnery," p. 196, &c. "Almost every projectile, besides the forces we have hitherto considered, namely, its gravitation, and that resistance of the air which directly opposes its motion, is affected by a third force which acts obliquely to its motion, and in a variable direction; and which, consequently, deflects the projectile from its regular track, and from the vertical plane in which it began to move; impelling it sometimes to one side, and sometimes to the other, occasioning thereby very great inequalities in the repeated ranges of the same piece, though each time loaded and pointed in the same manner; and this force, operating thus irregularly, I conceive to be the principal source of all that uncertainty and confusion in the art of gunnery, which hath hitherto been usually ascribed to the difference of powder. The reality of this force, and the cause which produces it, will, I hope, appear from the following considerations: 'It will easily be granted, I suppose, that no bullet can be discharged from the pieces generally in use, without rubbing against their sides, and thereby acquiring a whirling motion, as well as a progressive one; and as this whirl will, in one part of its revolution, conspire in some degree with the progressive motion, and in another part be equally opposed to it, the resistance of the air on the fore-part of the

bullet will be hereby affected, and will be increased in that part where the whirling motion conspires with the progressive, and diminished where it is opposed to it. And, by this means, the whole effort of the resistance, instead of being in a direction opposite to the direction of the body, will become oblique thereto, and will produce those effects already mentioned. If it were possible to predict the position of the axis, round which the bullet should whirl, and if that axis were unchangeable during the whole flight of the bullet, then the aberration of the bullet, by this oblique force, would be in a given direction, and the incurvation produced thereby, would regularly extend the same way, from one end of its track to the other. For instance: if the axis of the whirl were perpendicular to the horizon, then the deflection would be to the right or left; if that axis were horizontal, and perpendicular to the direction of the bullet, then the deflection would be upwards or downwards. But as the first position of this axis is uncertain, and as it may perpetually shift in the course of the bullet's flight, the deviation of the bullet is not necessarily in one certain direction, nor tending to the same side in one part of its track that it does in another; but it more usually is continually changing the tendency of its deflection, as the axis round which it whirls, must frequently shift its position to the progressive motion by many inevitable accidents."

RIGGING *of a ship*, is all her cordage and ropes, belonging to her masts, yards, &c. A ship is said to be well rigged, when all her ropes are of a fit size and proportion: and she is said to be over-rigged, when her ropes are too large, which is of great prejudice to her sailing, and is apt to make her heel.

RIGHT, in geometry, signifies the same with straight: thus, a straight line is called a right one.

RIGHT, in general signification, includes not only a right, for which a writ of right lies, but also any claim or title, either by virtue of a condition, mortgage, or the like, for which no action is given by law, but only an entry. A writ of right is the most ancient remedy in the law, for the recovery of lands, and is not barred till sixty years have elapsed since the claimant or his ancestor was disseised, or ousted of possession.

RING, in astronomy and navigation, an instrument used for taking the sun's altitude, &c. It is usually of brass, about nine inches diameter, suspended by a little swivel, at the distance of 45° from the point of which is a perforation, which is the centre of a quadrant of 90° divided in the inner concave surface. To use it, let it be held up by the swivel, and turned round to the sun, till its rays, falling through the hole, make a spot among the degrees, which marks the altitude required. This instrument is preferred before the astrolabe, because the divisions are here larger than on that instrument. See ASTROLABE.

RING, *of Saturn*, is a thin, broad, opaque circular arch, encompassing the body of that planet, like the wooden horizon of an artificial globe, without touching it, and appearing double when seen through a good telescope. See SATURN.

RINGS *of colours*, in optics, a phenomenon first observed in thin plates of various substances, by Boyle, and Hook, but afterwards more fully explained by Sir Isaac Newton. Mr. Boyle having exhibited a variety of colours in colourless liquors, by shaking them till they rose in bubbles, as well as in bubbles of soap and water, and also in turpentine, procured glass blown so thin as to exhibit similar colours; and he observes, that a feather of a proper shape and size, and also a black ribband, held at a proper distance between his eye and the sun, showed a variety of little rainbows, as he calls them, with very vivid colours. Dr. Hook, about nine years after the publication of Mr. Boyle's Treatise on *Colours*, exhibited the coloured bubbles of soap and water, and observed, that though at first it appeared white and clear, yet as the film of water became thinner, there appeared upon it all the colours of the rainbow. He also described the beautiful colours that appear in thin plates of Muscovy glass; which appeared, through the microscope, to be ranged in rings surrounding the white specks or flaws in them, and with the same order of colours as those of the rainbow, and which were often repeated ten times. He likewise took two thin pieces of glass, ground plane and polished, and putting them one upon another, pressed them till there began to appear a red coloured spot in the middle; and pressing them closer, he observed several rings of colours encompassing the first place, till, at last, all the colours disappeared out of the middle of the circle, and the central spot appeared white. The first colour that appeared was red, then yellow, then green, then blue, then purple; then again red, yellow, green, blue, and purple;

and again in the same order; so that he sometimes counted nine or ten of these circles, the red immediately next to the purple; and the last colour that appeared before the white was blue; so that it began with red, and ended with purple. These rings, he says, would change their places, by changing the position of the eye, so that the glasses remaining the same, that part which was red in one position of the eye, was blue in a second, green in the third, &c.

Sir Isaac Newton, having demonstrated that every different colour consists of rays which have a different and specific degree of refrangibility, and that natural bodies appear of this or that colour, according to their disposition to reflect this or that species of rays, pursued the hint suggested by the experiments of Dr. Hook, with regard to thin transparent substances. Upon compressing two prisms hard together, in order to make their sides touch one another, he observed, that in the place of contact they were perfectly transparent, which appeared like a dark spot, and when it was looked through, it seemed like a hole in that air, which was formed into a thin plate, by being impressed between the glasses. When this plate of air, by turning the prisms about their common axis, became so little inclined to the incident rays, that some of them began to be transmitted, there arose in it many slender arcs of colours, which increased, as the motion of the prisms was continued, and bended more and more about the transparent spot, till they were completed into circles, or rings, surrounding it; and afterwards they became continually more and more contracted. He then took two object-glasses of a telescope, the one plano-convex, the other a little convex on both sides, he placed one of the faces of this upon the plane face of the former, and pressed the two glasses at first gently, and then, by degrees, more closely against one another. The effect of this gradual pressure was an appearance in the plate of air between the glasses of different coloured circles, which had the point of contact for the common centre, and which increased in number according to the greater degree of pressure, in such a manner that the circle which appeared last always surrounded the point of contact, and on a still further pressure extended its circumference while it contracted itself breadthwise, to form a kind of ring round a new circle that arose near its middle. The pressure having been carried to a certain term, Newton stopped, and observed as follows. At the point of contact was a black spot that was encompassed by several series of colours. The order of the colours from the centre to the borders of the two glasses was this: in the first series, blue, white, yellow, and red; in the second, violet, blue, green, yellow, and red; in the third, purple, blue, green, yellow, and red; in the fourth, green and red; in the fifth, greenish blue and red; in the sixth, greenish, blue, and pale red; in the seventh, greenish blue, and reddish white. Beyond this number, the tints of which were regularly paler, the colour became white. Newton measured the diameters of the annular bands, formed of these different colours, by taking the points where they had most lustre; and he found that the squares of those diameters were to one another as the terms of the ascending progression, 1, 3, 5, 7, 9, 11, &c.; from which it results, that the intervals between the two glasses, relatively to the corresponding points, followed the same progression. From these proportions, it was merely necessary to ascertain the absolute length of a single diameter, to know the lengths of all the others, as well as the different thickness of the plates of air at the points where the different colours were seen. He drew up a table of these degrees of thickness, by which it appears, that the most intense blue, for example, that of the first series, is expressed by a thickness of 0.000024 of an inch, supposing the visual ray to be nearly perpendicular to the two glasses. Sir Isaac Newton having measured also the diameters of the rings at the intermediate places where the colours were obscure, found that their squares were to one another as the even numbers 2, 4, 6, 8, 10, 12, &c.; and hence the intervals between the glasses, at the corresponding points, observed a similar progression. The diameters of the rings increased or diminished, as the visual ray was more or less inclined to the surface of the two glasses, so that the greatest contraction took place when the eye was situated perpendicularly above the glasses. The diameters also retained the same proportions to one another.

From other curious observations on these rings, made by different kinds of light thrown upon them, he inferred, that the thicknesses of the air between the glasses, where the rings are successively made, by the limits of the seven colours, red, orange,

yellow, green, blue, indigo, and violet, in order, are one to another as the cube roots of the squares of the eight lengths of a chord, which sound the notes in an octave, sol, la, fa, sol, la, mi, fa, sol; that is, as the cube roots of the squares of the numbers 1, $\frac{8}{9}$, $\frac{5}{6}$, $\frac{3}{4}$, $\frac{2}{3}$, $\frac{3}{5}$, $\frac{9}{16}$, $\frac{1}{2}$. These rings appeared of that prismatic colour, with which they were illuminated, and by projecting the prismatic colours immediately upon the glasses, he found that the light, which fell on the dark spaces between the coloured rings, was transmitted through the glasses without any change of colour. From this circumstance he thought that the origin of these rings is manifest; because the air between the glasses is disposed according to its various thickness, in some places to reflect, and in others to transmit the light of any particular colour, and in the same place to reflect that of one colour, where it transmits that of another.

In examining the phenomena of colours made by a denser medium surrounded by a rarer, such as those which appear in plates of Muscovy glass, bubbles of soap and water, &c. the colours were found to be much more vivid than the others, which were made with a rarer medium surrounded by a denser. From the preceding phenomena it is an obvious deduction, that the transparent parts of bodies, according to their several series, reflect rays of one colour and transmit those of another; on the same account that thin plates, or bubbles, reflect or transmit those rays; and this Sir Isaac Newton supposed to be the reason of all their colours. Another inference is, that the particles even of those bodies which we call opaque are in reality transparent, which persons who are in the habit of using the microscope must continually perceive. See Newton's Optics: see also Colour, &c.

RIOT, *rout*, and *unlawful assembly*. When three persons, or more, assemble themselves together, with an intent mutually to assist one another, against any who shall oppose them in the execution of some enterprise of a private nature, with force or violence, against the peace, or to the manifest terror of the people, whether the act intended were of itself lawful or unlawful; if they only meet for such a purpose or intent, though they shall after depart of their own accord without doing any thing, this is an unlawful assembly. By 34 Edward III. c. 1, it is enacted, that if a justice find persons riotously assembled, he alone has not only power to arrest the offenders, and bind them to their good behaviour, or imprison them if they do not offer good bail; but he may also authorise others to arrest them, by a bare verbal command, without other warrant; and by force thereof, the persons so commanded may pursue and arrest the offenders in his absence, as well as presence. It is also said, that after any riot is over, any one justice may send his warrant to arrest any person who was concerned in it, and that he may send him to gaol till he shall find sureties for his good behaviour. The punishment of unlawful assemblies, if to the number of twelve, may be capital; according to the circumstances which attend them; but from the number of three to eleven, it is by fine and imprisonment only. The same is the case in riots and routs by the common law, to which the pillory, in very enormous cases, has been sometimes superadded.

By the act 1 George II. st. 2, c. 5, every justice, mayor, sheriff, &c. shall, upon notice of a riot, or unlawful, tumultuous assembly of twelve persons, proceed to the place, and make proclamation for them to depart, upon the pains of that act commonly called the riot-act. If any person shall wilfully oppose or hurt any person going to make proclamation, and prevent the same, he shall be guilty of felony, without benefit of clergy. If twelve continue together after proclamation, for one hour, it is felony, in like manner. And every justice, &c. shall apprehend persons, and if the rioters are killed, the justice, &c. shall not answer for it. A riot, though of fewer persons than twelve, to destroy any church, chapel, meeting, or dwelling-house, outhouse, &c. is a capital felony; and the hundred shall answer the damages, as in case of robbery.

If two justices go out to quell a riot, they may assemble the *posse comitatus*, and every person capable of travelling is, upon being warned, to join them, on pain of imprisonment. 13 Henry IV. c. 7, s. 1, 2, 11, 3. c. 8, s. 2.

RISBAN, in fortification, a flat piece of ground upon which a fort is *constructed* for the defence and security of a port or harbour. It likewise means the fort itself. The famous Risban, of Dunkirk, was built entirely of brick and stone; having within its walls excellent barracks, a large cistern well supplied with water, magazines for stores, provisions, and ammunition. A ready

communication was kept up with the town by means of the *jetée*, which corresponded with the wooden bridge that joined the entrance into the fort. The rampart was capable of receiving forty-six pieces of ordnance, which were disposed in three different alignements or tiers, owing to the triangular figure of the fort; so that a fire could be kept up on all sides.

RITTERA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Leguminosæ. Essential character: calyx four-leaved; petals one, lateral; legume one-celled, two-valved. There are five species.

RIVER, a current, or stream of fresh water, flowing in a bed or channel, from its source into the sea. When a stream is not large enough to bear boats, or small vessels laden, it is called a rivulet or brook. The great, as well as the middle-sized rivers, proceed either from a confluence of brooks and rivulets, or from lakes; but no river of considerable magnitude flows from one spring, or one lake, but is augmented by the accession of others. Thus the Wolga receives above two hundred rivers and brooks before it discharges itself into the Caspian Sea; and the Danube receives no less, before it enters the Euxine Sea. Some rivers are much augmented by frequent rains, or melted snow. In the country of Peru and Chili, there are small rivers, that only flow in the day; because they are only fed by the snow upon the mountains of the Andes, which is then melted by the heat of the sun. There are also several rivers upon both sides the extreme parts of Africa, and in India, which, for the same reason, are greater by day than by night. The rivers also in these places are almost dried up in summer, but swell and overflow their banks in winter, or in the wet season. Thus the Wolga in May and June is filled with water, and overflows its shelves and islands, though at other times of the year, it is so shallow, as scarcely to afford a passage for loaded ships. The Nile, the Ganges, the Indus, &c. are so much swelled with rain or melted snow, that they overflow their banks, and these deluges happen at different times of the year, because they proceed from various causes. Those that are swelled with rain are generally highest in winter, because it is usually then more frequent than at other times of the year; but if they proceed from snow, which, in some places, is melted in the spring, in others, in summer, or between both, the deluges of the rivers happen accordingly. Again, some rivers hide themselves under ground, and rise up in other places, as if they were new rivers. Thus the Tigris, meeting with mount Taurus, runs under it, and flows out at the other side of the mountain: also after it has run through the lake Tospis, it again immerges, and being carried about eighteen miles under ground, breaks out again, &c. The channels of rivers, except such as were formed at the creation, Varenius thinks, are artificial. His reasons are, that, when a new spring breaks out, the water does not make itself a channel, but spreads over the adjacent land; so that men were necessitated to cut a channel for it to secure their grounds. He adds, that a great number of channels of rivers are certainly known from history to have been dug by men. The water of most rivers flow impregnated with particles of metals, minerals, &c. Thus some rivers bring sands intermixed with grains of gold; as in Japan, Peru, and Mexico, Africa, Cuba, &c. particularly in Guinea is a river, where the negroes separate the gold-dust from the sand, and sell it to the Europeans, who traffic thither for that very purpose. The Rhine in many places is said to bring a gold mud. As to rivers that bring grains of silver, iron, copper, lead, &c. we find no mention of them in authors, though, doubtless, there are many, and it may be to them that mineral waters owe many of their medicinal virtues.

Modern philosophers endeavour to reduce the motion and flux of rivers to precise laws; and with this view they have applied geometry and mechanics to the subject; so that the doctrine of rivers is become a part of the new philosophy.

The authors, who have most distinguished themselves in this branch, are the Italians, and among them more especially Gulielmini, and Ximenes.

Rivers, says Gulielmini, usually have their sources in mountains or elevated grounds; in the descent from which it is mostly that they acquire the velocity, or acceleration, which maintains their future current. In proportion as they advance further, this velocity diminishes, on account of the continual friction of the water against the bottom and sides of the channel; as well as from the various obstacles they meet with in their progress, and from their arriving at length in plains where the descent is less, and consequently their inclination to the horizon greater.

When the acquired velocity is quite spent, through the many obstacles, so that the current becomes horizontal, there will then nothing remain to propagate the motion, and continue the stream, but the depth, or the perpendicular pressure of the water, which is always proportional to the depth. And this resource increases, as the occasion for it increases; for in proportion as the water loses of the velocity acquired by the descent, it rises and increases in its depth.

It appears from the laws of motion, pertaining to bodies moved on inclined planes, that when water flows freely upon an inclined bed, it acquires a velocity, which is always as the square root of the quantity of descent of the bed. But in an horizontal bed, opened by sluices or otherwise, at one or both ends, the water flows out by its gravity alone.

The greatest velocity of a river is about the middle of its depth and breadth, or that point which is the furthest possible from the surface of the water, and from the bottom and sides of the bed or channel. Whereas, on the contrary, the least velocity of the water is at the bottom and sides of the bed, because there the resistance arising from friction is the greatest, which is communicated to the other parts of the section of the river inversely as the distances from the bottom and sides. To find whether the water of a river, almost horizontal, flows by means of the velocity acquired in its descent, or by the pressure of its depth, set up an obstacle perpendicular to it; then if the water rise and swell immediately against the obstacle, it runs by virtue of its fall; but if it first stop a little while, in virtue of its pressure.

Rivers, according to this author, almost always make their own beds. If the bottom have originally been a large declivity, the water, hence falling with a great force, will have swept away the most elevated parts of the soil, and carrying them lower down, will gradually render the bottom more nearly horizontal.

The water, having made its bed horizontal, becomes so itself, and consequently rakes with the less force against the bottom, till at length that force becomes only equal to the resistance of the bottom, which is now arrived at a state of permanency, at least for a considerable time; and the longer according to the quality of the soil, clay and chalk resisting longer than sand or mud.

On the other hand, the water is continually wearing away the brims of its channel, and this with the more force, as, by the direction of its stream, it impinges more directly against them. By this means it has a continual tendency to render them parallel to its own course. At the same time that it has thus rectified its edges, it has widened its own bed, and thence becoming less deep, it loses part of its force and pressure: this it continues to do till there is an equilibrium between the force of the water and the resistance of its banks; and then they will remain without further change. And it appears, by experience, that these equilibriums are all real, as we find that rivers only deepen and widen to a certain pitch.

The union of two rivers into one makes the whole flow the swifter, because, instead of the friction of four shores, they have only two to overcome, and one bottom instead of two; also the stream, being further distant from the banks, goes on with the less interruption, besides, that a greater quantity of water, moving with a greater velocity, digs deeper in the bed, and of course retrenches of its former width. Hence also it is, that rivers, by being united, take up less space on the surface of the earth, and are more advantageous to low grounds which drain their superfluous moisture into them, and have also less occasion for dykes to prevent their overflowing.

A very good and simple *method of measuring* the velocity of the current of a river, or canal, is the following. Take a cylindrical piece of dry light wood, and of a length something less than the depth of the water in the river; about one end *of it let* there be suspended as many small weights, as may keep the cylinder in a vertical or upright position, with its *head just above* water. To the centre of this end fix a small straight rod, precisely in the direction of the cylinder's axis; to the end that, when the instrument is suspended in the water, the deviations of the *rod from a per*pendicularity to the surface of it, may indicate which end of the cylinder goes foremost, by which may be *discovered the dif*ferent velocities of the water at different depths; for when the rod inclines forward, according to the direction of the current, it is a proof that the surface of the water has the greatest velocity; but *when it re*clines backward, it shows that the swiftest current is at the bottom; and when it remains perpendicular, it *is a sign that the*

velocities at the top and bottom are equal. This instrument, being placed in the current of a river or canal, receives all the percussions of the water throughout the whole depth, and will have an equal velocity with that of the whole current from the surface to the bottom at the place where it is put in, and by that means may be found, both with exactness and ease, the mean velocity of that part of the river for any determinate distance and time. But to obtain the mean velocity of the whole section of the river, the instrument must be put successively both in the middle and towards the sides, because the velocities at those places are often very different from each other. Having by this means found the several velocities, from the spaces run over in certain times, the arithmetical mean proportional of all these trials, which is found by dividing the common sum of them, all by the number of the trials, will be the mean velocity of the river or canal. And if this medium velocity be multiplied by the area of the transverse section of the waters at any place, the product will be the quantity running through that place in a second of time.

If it be required to find the velocity of the current only at the surface, or at the middle, or at the bottom, a sphere of wood loaded, or a common bottle corked with a little water in it, of such a weight as will remain suspended in equilibrium with the water at the surface or depth which we want to measure, will be better for the purpose than the cylinder, because it is only affected by the water of that sole part of the current where it remains suspended.

It follows from what has been said in the former part of this article, that the deeper the waters are in their bed in proportion to its breadth, the more their motion is accelerated; so that their velocity increases in the inverse ratio of the breadth of the bed, and also of the magnitude of the section; whence, in order to augment the velocity of water in a river or canal, without augmenting the declivity of the bed, we must increase the depth of the channel, and diminish its breadth. And these principles are agreeable to observation: as it is well known, that the velocity of flowing waters depends much more on the quantity and depth of the water, and on the compression of the upper parts on the lower, than on the declivity of the bed; and therefore the declivity of a river must be made much greater in the beginning than toward the end of its course; where it should be almost insensible.

RIVINA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx four-leaved, permanent; berry containing one lens-shaped seed. There are four species.

ROAD, an open way, or public passage, forming a communication between one place and another. The Romans took the most pains in forming roads, and the labour and expenses they were at in rendering them spacious, firm, straight, and smooth, is incredible. They usually strengthened the ground by ramming it, laying it with flints, pebbles, or sand, and sometimes with a lining of masonry, rubbish, bricks, &c. bound together with mortar. In some places in the Lionois, F. Menestrier observes that he has found huge clusters of flints cemented with lime, reaching ten or twelve feet deep, and making a mass as hard and compact as marble, and which, after resisting the injuries of time for 1600 years, is still scarce penetrable by all the force of hammers, mattocks, &c. and yet the flints it consists of are not bigger than eggs. The most noble of the Roman roads was the Via Appia, which was carried to such a vast length, that Procopius reckons it five days journey to the end of it, and Leipsius computes it at 350 miles: it is 12 feet broad, and made of square free-stone, generally a foot and a half on each side; and though this has lasted for above 1800 years, yet in many places it is for several miles together as intire as when it was first made.

The ancient roads are distinguished into military roads, double roads, subterraneous roads, &c. the military roads were grand roads, formed by the Romans for marching their armies into the provinces of the empire; the principal of these Roman roads in England, are Watling-street, Ikenild-street, Foss-way, and Erminage-street.—Double roads, among the Romans, were roads for carriages, with two pavements, the one for those going one way, and the other for those returning the other: these were separated from each other by a causeway raised in the middle, paved with bricks for the conveniency of foot passengers; with borders and mounting stones from space to space, and military columns to mark the distance. Subterraneous roads are those dug through a rock, and left vaulted; as that of Puzzoli near Naples, which is nearly

half a league long, and is 15 feet broad, and as many high.

Road, in navigation, is a place of anchorage at some distance from shore, where vessels usually moor, to wait for a wind or tide proper to carry them into harbour, or to set sail. When the bottom is firm, clear of rocks, and sheltered from the wind, it is called a good road; and when there is but little land on any side, it is termed an open road.

The roads in his Majesty's dominions are free to all merchant vessels belonging to his subjects and allies. Captains and masters of ships who are forced by storms, &c. to cut their cables, and leave their anchors in the roads, are obliged to fix marks, or buoys, on pain of forfeiting their anchors, &c. Masters of ships coming to moor in a road, must cast anchor at such a distance as that the cables, &c. do not mix, on pain of answering the damages; and when there are several vessels in the same road, the outermost to the sea-ward is obliged to keep a light in his lanthorn in the night-time, to apprise vessels coming in from sea.

ROASTING, in metallurgy, the separation of volatile bodies from those which are more fixed, by the combined action of air and fire; and is generally the first process in the separation of metals from their ores: it differs from sublimation only in this, that in this operation the volatile parts are dissipated, when resolved into vapours: whereas in that, they are preserved.

ROBBERY, is a felonious taking away of another man's goods from his person, or presence, against his will, putting him in fear, on purpose to steal the same. The value is immaterial.

If a man force another to part with his property, for the sake of preserving his character from the imputation of having been guilty of an unnatural crime, it will amount to a robbery, even though the party was under no apprehension of personal danger. If any thing is snatched suddenly from the head, hand, or person of any one, without any struggle on the part of the owner, or without any evidence of force, or violence being exerted by the thief, it does not amount to robbery. But if any thing be broken or torn in consequence of the sudden seizure, it would be evidence of such force as would constitue a robbery: as where a part of a lady's hair was torn away by snatching a diamond pin from her head, and an ear was torn by pulling off an ear-ring; each of these cases was determined to be a robbery.

By 7 George II. c. 21, if any person shall with any offensive weapon, assault, or by menaces, or in any forcible or violent manner, demand any money or goods, with a felonious intent to rob another, he shall be guilty of felony, and be transported for seven years.

If any person being out of prison, shall commit any robbery, and afterwards discover two or more persons who shall commit any robbery, so as two or more be convicted, he shall have the King's pardon for all robberies he shall have committed before such discovery.

Highway-robbery differs from robbery only in this, that there is a reward of [illegible] for the apprehending of the offender, and the horse which the robber rides is forfeited.

ROBERGIA, in botany, so named in honour of Laurentius Roberg, a genus of the Decandria Pentagynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx five-parted; petals five; drupe with a one-seeded nut, and a two-valved shell. There is but one species, viz. R. frutescens, a native of the woods of Guiana.

ROBINIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx four-cleft; legume gibbous, elongated. There are seventeen species.

ROBINS (Benjamin), in biography, an English mathematician and philosopher, of great genius and eminence, was born at Bath, in Somersetshire, 1707. His parents were of low condition, and quakers: and, consequently, neither able from their circumstances, nor willing from their religious profession, to have him much instructed in that kind of learning which they are taught to despise as human. Nevertheless he made an early and surprising progress in various branches of science and literature, particularly in the mathematics; and his friends being desirous that he might continue his pursuits, and that his merit might not be buried in obscurity, wished that he could be properly recommended to teach that science in London. Accordingly, a specimen of his abilities, in this way, was sent up thither, and shown to Dr. Pemberton, the author of the "View of Sir Isaac Newton's Philosophy;" who thence, conceiving a good opinion of the writer, for a further trial of his skill, sent him some problems, which Robins resolved very much to his satisfaction. He then came to Lon-

don, where he confirmed the opinion which had been preconceived of his abilities and knowledge.

But though Robins was possessed of much more skill than is usually required in a common teacher; yet being very young, it was thought proper that he should employ some time in perusing the best writers, upon the sublimer parts of the mathematics, before he should undertake publicly the instruction of others. In this interval, besides improving himself in the modern languages, he had opportunities of reading, in particular, the works of Archimedes, Apollonius, Fermat, Huygens, De Witt, Slusius, Gregory, Barrow, Newton, Taylor, and Cotes. These authors he readily understood without any assistance, of which he gave frequent proofs to his friends: one was, a demonstration of the last proposition of "Newton's Treatise on Quadratures," which was thought not undeserving a place in the Philos. Trans. for 1727.

Not long after an opportunity offered him of exhibiting to the public a specimen also of his knowledge in natural philosophy. The Royal Academy of Sciences at Paris had proposed, among their prize questions in 1724 and 1726, to demonstrate the laws of motion in bodies impinging on one another. John Bernoulli here condescended to be a canditate; and as his dissertation lost the reward, he appealed to the learned world by printing it in 1727. In this piece he endeavoured to establish Leibnitz's opinion of the force of bodies in motion from the effects of their striking against springy materials; as Poleni had before attempted to evince the same thing from experiments of bodies falling on soft and yielding substances. But as the insufficiency of Poleni's arguments had been demonstrated in the Philos. Trans. for 1722; so Robins published in the "Present State of the Republic of Letters," for May 1728, a Confutation of Bernoulli's performance, which was allowed to be unanswerable.

Robins now began to take scholars. About this time he quitted the dress and profession of a quaker; and, probably, without reflecting very much upon the subject of religion, he soon shook off the prejudices of his early habits. But though he professed to teach the mathematics only, he would frequently assist particular friends in other matters; for he was a man of universal knowledge; and the confinement of this way of life not suiting his disposition, which was active, he gradually declined it, and went into other courses that required more exercise. Hence he tried many laborious experiments in gunnery; believing that the resistance of the air had a much greater effect on swift projectiles, than was generally supposed. And hence he was led to consider those mechanic arts that depend upon mathematical principles, in which he might employ his invention; as the constructing of mills, the building of bridges, draining of fens, rendering of rivers navigable, and making of harbours. Among other arts of this kind, fortification very much engaged his attention; in which he met with opportunities of perfecting himself, by a view of the principal strong places of Flanders, in some journies he made abroad with persons of distinction.

On his return home from one of these excursions, he found the learned here amused with Dr. Berkeley's treatise, printed in 1734, entitled "The Analyst," in which an examination was made into the grounds of the Doctrine of Fluxions, and occasion thence taken to explode that method. Robins was, therefore, advised to clear up this affair, by giving a full and distinct account of Newton's doctrines, in such a manner as to obviate all the objections, without naming them which had been advanced by Berkeley, and accordingly he published, in 1735, a Discourse concerning the Nature and Certainty of Sir Isaac Newton's Method of Fluxions, and of Prime and Ultimate Ratios. This is a very clear, neat, and elegant performance; nevertheless some persons, even among those who had written against the Analyst, taking exception at Robins's manner of defending Newton's doctrine, he afterwards wrote two or three additional discourses.

In 1738, he defended Newton against an objection, contained in a note at the end of a Latin piece, called "Matho, sive Cosmotheoria puerilis," written by Baxter, author of the "Inquiry into the Nature of the Human Soul:" and the year after he printed Remarks on Euler's Treatise of Motion, on Smith's System of Optics, and on Jurin's Discourse of Distinct and Indistinct Vision, annexed to Dr. Smith's work.

In the meantime Robins's performances were not confined to mathematical subjects; for, in 1739, there came out three pamphlets upon political affairs, which did him great honour. The first was entitled, "Observations on the present Convention with Spain;" the second, "A Narrative of

what passed in the Common-Hall of the Citizens of London, assembled for the Election of a Lord Mayor;" the third, "An Address to the Electors and other Free Subjects of Great Britain, occasioned by the late Succession; in which is contained a particular account of all our negociations with Spain, and their treatment of us for above ten years past." These were all published without our author's name; and the first and last were so universally esteemed, that they were generally reputed to have been the production of the great man himself, who was at the head of the opposition to Sir Robert Walpole. They proved of such consequence to Mr. Robins, as to occasion his being employed in a very honourable post; for, the patriots at length gained ground against Sir Robert, and a Committee of the House of Commons being appointed to examine into his past conduct, Robins was chosen their Secretary. But after the Committee had presented two reports of their proceedings, a sudden stop was put to their further progress, by a compromise between the contending parties.

In 1742, being again at leisure, he published a small treatise, entitled "New Principles of Gunnery;" containing the result of many experiments he had made, by which are discovered the force of gunpowder, and the difference in the resisting power of the air to swift and slow motions. To this treatise was prefixed a full and learned account of the progress which modern fortification had made from its first rise; as also of the invention of gunpowder, and of what had already been performed in the theory of gunnery. It seems that the occasion of this publication was the disappointment of a situation at the Royal Military Academy at Woolwich. On the new modelling and establishing of that Academy, in 1741, our author and the late Mr. Muller, were competitors for the place of Professor of Fortification and Gunnery. Mr. Muller held then some post in the Tower of London, under the Board of Ordnance, so that, notwithstanding the great knowledge and abilities of our author, the interest which Mr. Muller had with the Board of Ordnance, carried the election in his favour. Upon this disappointment Mr. Robins, indignant at the affront, determined to show them, and the world, by his military publications, what sort of a man he was that they had rejected.

Upon a discourse containing certain experiments being published in the Philos. Trans. with a view to invalidate some of Robins's opinions, he thought proper, in an account he gave of his book in the same Transactions, to take notice of those experiments: and in consequence of this, several dissertations of his, on the resistance of the air were read, and the experiments exhibited before the Royal Society, in 1746 and 1747; for which he was presented with the annual gold medal by that society.

In 1748, came out "Anson's Voyage round the World;" which, though it bears Walter's name in the title-page, was, in reality, written by Robins. Of this voyage the public had for some time been in expectation of seeing an account, composed under that commander's own inspection: for which purpose the Reverend Richard Walter was employed, as having been Chaplain on board the Centurion, the greatest part of the expedition. Walter had accordingly almost finished his task, having brought it down to his own departure from Macao for England; when he proposed to print his work by subscription. It was thought proper, however, that an able judge should first review and correct it, and Robins was appointed; when, upon examination, it was resolved that the whole should be written entirely by Robins, and that what Walter had done being mostly taken, verbatim, from the journals, should serve as materials only. Hence it was that the whole of the introduction, and many dissertations in the body of the work, were composed by Robins, without receiving the least hint from Walter's manuscripts; and what he had transcribed from it regarded chiefly the wind and weather, the currents, courses, bearings, distances, offings, soundings, moorings, the qualities of the ground they anchored on, and such particulars as usually fill up a seaman's account. No production of this kind ever met with a more favourable reception, four large impressions having been sold off within a year: it was also translated into most of the European languages; and it still supports its reputation, having been repeatedly reprinted in various sizes. The fifth edition, at London, in 1749, was revised and corrected by Robins himself; and the ninth edition was printed there in 1761.

Thus becoming famous for his elegant talents in writing, he was requested to compose an apology for the unfortunate affair at Preston-Pans in Scotland. This was added as a preface to the report of the proceedings and opinion of the board of general officers

on their examination into the conduct of Lieutenant General Sir John Cope, &c. printed at London in 1749; and this preface was esteemed a master-piece of its kind.

Robins, had afterwards, by the favour of Lord Anson, opportunities of making further experiments in gunnery; which have been published since his death, in the edition of his works by his friend Dr. Wilson. He also not a little contributed to the improvements made in the Royal Observatory at Greenwich, by procuring for it, through the interest of the same noble person, a second mural quadrant, and other instruments; by which it became perhaps the completest observatory of any in the world.

His reputation being now arrived at its full height, he was offered the choice of two very considerable employments. The first was to go to Paris as one of the commissaries for adjusting the limits in Acadia; the other, to be engineer general to the East India Company, whose forts being in a most ruinious condition, wanted an able person to put them into a proper state of defence. He accepted the latter, as it was suitable to his genius, and as the Company's terms were both advantageous and honourable.

He designed, if he had remained in England, to have written a second part of the voyage round the world, as appears by a letter from Lord Anson to him, dated Bath, October 22, 1749, as follows.

"Dear Sir, when I last saw you in town, I forgot to ask you, whether you intended to publish the second volume of my voyage before you leave us; which I confess I am very sorry for. If you should have laid aside all thoughts of favouring the world with more of your works, it will be much disappointed, and no one in it more than your very obliged humble servant,

"ANSON."

Robins was also preparing an enlarged edition of his New Principles of Gunnery; but, having provided himself with a complete set of astronomical and other instruments, for making observations and experiments in the Indies, he departed hence at Christmas in 1749; and after a voyage, in which the ship was near being cast away, he arrived at India in July following. There he immediately set about his proper business with the greatest diligence, and formed complete plans for Fort St. David, and Madras, but he did not live to put them into execution. For the great difference of the climate from that of England being beyond his constitution to support, he was attacked by a fever in September the same year; and though he recovered out of this, yet about eight months after he fell into a languishing condition, in which he continued till his death, which happened the 29th of July 1751, at only 44 years of age.

By his last will, Mr. Robins left the publishing of his mathematical works to his honoured and intimate friend Martin Folkes, Esq. President of the Royal Society, and to Dr. James Wilson; but the former of these gentlemen being incapacitated by a paralytic disorder, some time before his death, they were afterwards published by the latter, in 2 vols. 8vo, 1761. To this collection, which contains his mathematical and philosophical pieces only, Dr. Wilson has prefixed an account of Mr. Robins, from which this memoir is chiefly extracted. He added also a large appendix, at the end of the second volume, containing a great many curious and critical matters in various interesting parts of the mathematics.

It is but justice to say, that Mr. Robins was one of the most accurate and elegant mathematical writers that our language can boast of; and that he made more real improvements in artillery, the flight and the resistance of projectiles, than all the preceding writers on that subject. His new principles of gunnery were translated into several other languages, and commented upon by several emiment writers. The celebrated Euler, translated the work into the German language, accompanied with a large and critical commentary; and this work of Euler's was again translated into English in 1714, by Mr. Hugh Brown, with notes, in one volume quarto.

ROBINSONIA, in botany, a genus of the Icosandria Monogynia class and order. Essential character: calyx five-toothed; petals five; berry striated, two-celled; cells one-seeded; seeds villose. There is but one species, viz. R. melianthifolia, a native of Guiana.

ROCHEFORTIA, in botany, so named in memory of De Rochefort, a genus of the Pentandria Digynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx five-parted; corolla one petalled, funnel-form, inferior, with the aperture open; fruit two-celled, many-seeded. There are two species, viz,

R. cuneala, and R. ovata, both natives of Jamaica.

ROCK, a stony mass, forming a portion of the substance of this globe. Rocks are in general disposed in mountanic ranges; but in some few instances are found existing in immensely large separate masses.

The obvious differences existing in the appearances and composition of different rocks and mountains have long induced mineralogists to consider them as formed at very distant periods from each other, and even to suppose, that those of the later formation frequently derived the materials of which they were composed, from the disintegration of the previously existing, and much more ancient rocks. Hence arose their division into primeval, or primitive; and secondary, or epizootic; and in consequence of the prevalence of the opinion of the primitive rocks supplying the materials of those of secondary formation, the latter were further separated into original and derivative. The secondary rocks were also considered as otherwise differing in their origin; some being supposed to be marigenous, and others alluvial.

The celebrated Werner considers all rocks, with respect to their origin, to be aquatic or ignigenous. The aquatic are divided, agreeable to the period, and the particular mode of their formation, into, 1. Primitive, being chemical precipitates, bearing no traces of organised beings, and formed in the early chaotic state of the earth. 2. Transition, formed, as the term implies, during the transition of the earth into a habitable state. 3. Floëtz rocks, disposed in flat or horizontal strata, after the creation of animals and vegetables; the remains of which are often found in the substance of these rocks: as the primitive are of purely chemical, so the two latter are of partly chemical, and partly mechanical formation. 4. Alluvial, formed by the component parts of previously existing rocks, separated by the influence of air, water, and change of temperature, and deposited in beds. 5. Volcanic rocks, which, according to their originating from true volcanoes, or from pseudo-volcanoes, are considered as volcanic, or pseudo-volcanic.

Mountain rocks are simple, as when formed of limestone, clay-slate, serpentine, or any other simple fossil; and compound, when formed by the aggregations of simple fossils. The compound rocks are either cemented, formed of various parts brought together and connected by a cement, as in sand-stones, pudding-stones, and breccias or are aggregated, being composed of parts existing originally on the spot where the masses are now found, and connected together by their original structure. They are also considered as simple aggregated, when one, as a base includes the other; when the contained portion is in the form of grains or crystals, the structure is termed porphyritic; and when of a vesicular form, amygdaloidal: the double aggregated is when a smaller structure is contained in a larger, as granular slaty; or when the two structures exist near or beside each other: when the one not including the other is pointed out by a conjunction, as porphyritic and amygdaloidal.

The mountain masses themselves are either of a stratified or of a seamed structure. When the masses composing the rock are of one species, and disposed parallel to each other, those masses are termed strata; but when the mountain mass is composed of different species of rocks; thus disposed, it is said to be formed of beds. In the seamed structure, the seams of stratification, though parallel in one direction, intersect each other in another. The masses thus divided by these intersecting seams, may be considered as distinct concretions, and may be instanced in the columnar formed. Straight and much thicker masses are also thus formed, by what is termed the tabular seamed structure, and large globular masses result from the large globular or massive structure.

By a rock formation, Mr. Jameson understands "a determinate assemblage of similar or dissimilar rock masses, which are characterised by external and internal relations, as an independent whole, that is, as an unity in the series of rock formations." When the mass is uniform throughout, it constitutes a simple formation; but when dissimilar, a compound formation; and when these formations are repeated, the whole is denominated a series or suite of formations. When individual beds occur in different principal formations, as primitive trap in gneiss, mica-slate, &c. forming single independent wholes, which always continue the same, notwithstanding the difference of rocks in which they are imbedded, and still form members of a series of formations; they are considered as independent formations. The inclination of a stratum is the angle which the stratum forms with the horizon, and is determined by the quadrant. The dip is the point of the compass to-

wards which the stratum inclines. The direction is the angle which the stratum makes with the meridian, and is determined by the compass. It is always at right angles to the dip.

The primitive rocks are chiefly composed of substances, which chiefly consist of the siliceous and argillaceous earths. 1. Granite, the moor-stone of Cornwall, is a granular rock composed of felspar, mica, and quartz, united in various proportions.—Schorl, garnet, tin-stone, adularia, chlorite, and rock crystal, are among the accidental minerals which occur in this rock: it sometimes exists in large distinct globular, and sometimes in columnar concretions: it is sometimes stratified, but seldom contains any foreign beds. 2. Gneiss, is a stratified rock, formed of the same component parts as granite, but the mica exists in larger proportion than in granite: it sometimes contains schorl, and, but more rarely, garnet and hornblende: its structure passes from that which approaches to the granular structure of granite, to the undulated, and even the slaty structure. It is very frequently metalliferous, there being few metals which are not found in it. 3. Mica slate is likewise a distinctly stratified rock, which rests on gneiss: it is composed of mica and quartz, disposed in a slaty structure: it frequently contains garnets, and sometimes hornblende, schorl, and tourmaline, kyanite, rutile, and felspar. Like gneiss it is frequently metalliferous, the ores generally occurring in beds; whereas in gneiss the ore is most frequently found in veins. 4. Clay-slate is a simple rock, and follows the foregoing in the series of primitive rocks: it sometimes contains schorl, tourmaline, garnet, hornblende, chiastolite, and actynolite. There appear to be four different kinds of clay-slate, chiefly distinguishable by their colours: yellowish grey which connects clay-slate with mica slate; dark and bluish grey, used as roof-slate; greenish grey, and lastly bluish and reddish grey, containing a few scales of mica. The rocks peculiar to this formation are whet-slate, roof-slate, chlorite-slate, talc-slate, alum-slate, drawing-slate, pot-stone, and flinty-slate. This, like those already mentioned, is a widely extended rock, and is also one of the most metalliferous. 5. Primitive lime-stone, is a simple mountain rock, which is more or less distinctly stratified, and is frequently metalliferous; its colours are various, and its structure is always granular. Quartz and mica frequently occur in it accidentally: it also sometimes contains hornblende, actynolite, asbestos, serpentine, talc, steatite, tremolite, garnet, calcareous spar, and slate spar. 6. Primitive trap, is a mountain which seems intimately connected with clay-slate. The term trap had been long used without a definite signification; but Werner has restricted its application to rocks, principally containing hornblende, and black iron-clay; the iron-clay first appearing in the transition, and increasing in rocks of the newer periods. There are three distinct species of primitive trap. Common hornblende rock, under which are comprised, hornblende rock, and hornblende slate. Hornblende with felspar, a subordinate kind of which is greenstone, which has the following varieties: common greenstone, a granular aggregate of hornblende and felspar. Porphyritic greenstone is the former, containing crystals of felspar. Greenstone porphyry, is the black porphyry of the ancients; crystals of felspar are here also included, but the granular structure of the basis is hardly discoverable. Green porphyry, in which the granular structure is no longer visible, and crystals of compact felspar are included. The second species of primitive trap is greenstone slate, composed of hornblende and compact felspar, arranged in a slaty structure; and the third is an intimate mixture of hornblende with felspar, including mica in scales. It is found in beds in gneiss and mica-slate. 7. Serpentine is a simple mountain rock, indistinctly stratified. A great variety of other mineral bodies are found in it, and it is sometimes indeterminately mixed with limestone, forming what is termed *verde antico*. 8. Porphyry is a compound rock formed of one substance in the form of grains or crystals, imbedded in another as its basis. The base is clay-stone, hornstone, compact felspar, pitch-stone, pearl-stone, or obsidian: the imbedded crystals are of quartz or felspar. There appears to be two formations of porphyry; the oldest consists principally of hornstone and felspar porphyry; and the newer of clay, pitch-stone, pearl-stone, and obsidian porphyry. 9. Sienite is a compound, granular, aggregated rock, formed of felspar and hornblende, and sometimes containing quartz and black mica. The hornblende distinguishes this rock from granite; but the felspar, which is almost always red, and sel-

dom inclining to green, is the most abundant and essential portion of the rock; a circumstance which distinguishes it from greenstone, in which the felspar predominates, and is of a greenish colour; whilst in sienite it is red or reddish. 10. Topaz rock is composed of quartz, topaz schorl, and a small portion of lithomarge: the stratification of this rock is uncommonly distinct. 11. Quartz rock is a simple mountain rock, composed of small and flattish granular distinct concretions. This, as well as the former rock, is not very frequently met with, nor is of considerable extent. 12. Primitive flinty-slate is a simple rock, of which there exist two subspecies; common flinty slate, and Lydian stone. It is met with in considerable beds in clay-slate. 13. Primitive gypsum, is a simple rock, which is distinguishable from the newer gypsum, by its being mixed with mica and clay-slate. 14. White stone is a rock, which is sometimes of a slaty, and sometimes of a granular structure, and is chiefly composed of compact felspar, with a small proportion of mica.

Whilst the primitive mountains were still covered with water, it is supposed that a considerable rising of the waters took place, from which were deposited rocks of porphyry, sienite and pitch stone. These contain very little mechanical deposition, no petrifactions, and little or no carbonaceous matter. These rocks are considered as the second porphyry and sienite formations.

The rocks which are considered as transition rocks are, 1. Transition limestone, differing from the primitive in its variety of colours, and by its containing the remains of marine animals; and from the floëtz in its minute granular structure giving a splintery or flat conchoidal fracture. 2. Transition trap; under which species we have transition green stone, distinguished by being less crystalline than the primitive, and more so than the floëtz; and transition amygdaloid. 3. Grey wacké, which is more abundant than the two preceding, and also marks a particular period in the formation of rocks, it possessing the appearance of mechanical deposition. There are two kinds, grey wacké and grey wacké slate: the former is a sand-stone, differing from those of later formation, in being composed of portions of sand of larger size in grey coloured clay-slate; the latter obtains its slaty structure, in a great measure, from the smallness of the sandy particles. This rock is extremely abundant in metals, and is very generally distributed. 4. Transition flinty slate. 5. Transition gypsum. The two latter do not appear to be decidedly distinguished from those of the other periods.

The floëtz rocks, formed by risings of the waters after the creation of animals and vegetables, seldom reach to a very great height: those of what is termed the newest floëtz trap formation, form, however, an exception; since they cover the summits of very high mountains, and show their formation to have been at a different period, and when the waters were higher than when the other floëtz rocks were formed. Of these rocks limestone is the most prevalent; and in the rocks of this formation bituminous fossils, and the petrifactions of vegetables and animals, are very numerous, and in great variety.

The rocks of this class are the following: 1. The first sand-stone formation, which is called the old red sand-stone; the grains are usually quartz and flinty slate, cemented by iron-shot clay. 2. Variegated sand-stone, or second sand-stone formation; which is marked with, and is also disposed in, layers of different colours. 3. Third sand-stone formation; which is always white, and appears to be of much later formation than those just mentioned. 4. Partial sand-stone formation. 5. Floëtz lime-stone, is a simple rock, and is more distinctly stratified than any other rock. Two distinct formations are described; the first floëtz lime-stone, and the second floëtz, or shell lime-stone. 6. Floëtz gypsum is also a simple rock, and is more or less distinctly stratified. Of these rocks also there appears to be, beside others, two principal formations. 7. Rock-salt formation. It is mostly found in short, but thick, beds, in clay in a state between common and indurated clay. 8. Chalk is reckoned one of the newest of the floëtz formations. It generally contains flint, and the petrifactions of marine animals. 9. Floëtz trap is supposed by Mr. Jameson to result from a formation different from that which Werner has named the newest floëtz trap. 10. Coal formation. Werner describes three formations of coal; the oldest, or independent coal formation; that which occurs in the newest floëtz trap formation; and that which occurs in alluvial land. 11. Newest floëtz trap formation, which includes several rocks, particularly basalt, wacké, grey-stone, porphyry-slate, and trap-tuff, which are its peculiar and characteristic rocks. Those which occur in

it, as well as in the other floëtz formations, are green-stone, amygdaloid, pitch-stone, obsidian, pumice, compact felspar, clay-stone; gravel, sand, and clay; sand-stone, clay iron stone, lime-stone, iron-clay, and coal. The form, and other visible characters, of many of the mountain rocks are frequently sufficient to point out their nature to the attentive observer. Granite is characterised by its very high and precipitous cliffs and peaks; gneiss is less lofty, and its summits are less steep and abrupt; and the mountains of mica-slate are still less lofty, and bear more of a rounded form. Clay-slate mountains are generally less lofty than those already noticed, and their cliffs are still less steep and rough. Primitive lime-stone sometimes presents lofty peaks, like those of granite; but the mountains containing it in general assume the characters of gneiss, mica-slate, or clay-slate, with which it is in general found. Rocks of primitive trap are generally lofty, steep, and conical. "No rock," Mr. Jameson observes, "presents a greater variety of external appearance than the sand-stone. Its vallies are deep, rocky, and romantic; its hills are conical, steep, and cliffy; and it often presents grand colossal pillars, which, from their number, and variety of their shape, form most striking rocky scenes." Floëtz lime-stone assumes very different forms from those already particularised, being extended in large, flat hills, intersected by steep vallies. Chalk in some situations forms hills of considerable height, which are generally rounded, with an extensive base.

The position, extent, and direction of the several strata of different formations, either taken with or without reference to the fundamental rock, yield very convincing testimony in favour of the opinions delivered by the celebrated Werner respecting the formation of the earth. (See Geology.) Previously to viewing the illustration of his theory in the formation of a suite of rocks, it may be necessary to particularise some of the peculiarities in the formation of different rocks, and to show the different terms by which they are expressed. The formations themselves are distinguished as universal or partial, and as unbroken or broken. The strata are considered as conformable or unconformable, with the direction of the fundamental rock; and overlying, when lying over the ends of the strata of the fundamental rock. They are said to be straight, when disposed in one direction on the fundamental rock: when they turn round it, leaving the top uncovered, mantle-formed; and when they also cover its extremities, saddle-formed. When concave, they are termed basin-shaped; and if the concavity is long, trough-shaped. Their upper extremities, appearing at the surface of the earth, are termed the outgoings of the strata: the outermost of the circles formed by these is the oldest in the concave (the basin and trough-shaped), and newest in the convex (the mantle and saddle-shaped). When detached portions occur on the summits of hills, they are called caps; when filling up hollow spaces, up-fillings; and when only on one side of a mountain, shield-formed.

It has been here said, according to the theory of Werner, that one class of mountains was deposited, by chemical formation from an aqueous solution, previous to the creation of vegetables and animals: that to these succeeded another class, in which materials mechanically separated were discoverable, formed during the passage of this globe into a habitable state; and that during the existence of animals and vegetables in considerable number, another (the latest) class was produced, in which mechanical deposits and remains of organized bodies exist in considerable quantity. Of these different classes of rocks, it may be expected, that the rocks of the earliest period would be found invested in various modes by those of later formation, and disposed in the order of their separation from the waters from which they derived their origin.

The rocks which exist in the Hartz appear to be beautifully illustrative of this successive deposition. In the centre a vast mass of granite rises through the other strata, and round this clay-slate is disposed in mantle-shaped strata. Gneiss and mica-slate not existing in this country, transition limestone succeeds to the clay-slate, and then grey wacké and grey wacké slate: the whole being wrapped round the granite in mantle-shaped strata, and invariably with lower and lower outgoings, corresponding to the newer and newer strata. To these the floëtz rocks succeed, the oldest of the floëtz resting on the newest of the transition; and the different floëtz rocks resting on each other according to their relative age. Last of all, the alluvial rocks are found in the lowest situations. We have thus, as Mr. Jameson observes, all the series of rocks, from the granite to the alluvial, marked with a diminishing level, in proportion to the newness of the strata.

The system of Werner, formed upon a most comprehensive view of the several phenomena observable in the formation

of the crust of this globe, has been here adopted, from Professor Jameson's perspicuous description of it, on account of its so exactly corresponding with the appearances which masses of rocks every where present to our view. The present outline, though perhaps sufficiently correct, is, however, by no means pretended to supersede the study of the work alluded to; since an accurate knowledge of the subject can only be yielded by the study of the more highly finished performance itself.

ROCKET. See PYROTECHNY.

ROD, a land measure of sixteen feet and a half; the same with perch and pole.

ROELLA, in botany, so named in honour of William Roell, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: corolla funnel-form, with the bottom closed by staminiferous valves; stigma bifid; capsule two-celled, cylindrical, inferior. There are five species, all natives of the Cape of Good Hope.

ROHRIA, in botany, so named in honour of Julius von Rohor, a genus of the Triandria Monogynia class and order. Essential character: calyx bell-shaped, five-parted; corolla five-petalled, unequal; stigmas three, revolute; capsule. There is but one species, *viz.* R. petioliflora, a native of the woods of Guiana.

ROGUE. See VAGRANT.

ROHAULT (JAMES), in biography, a French philosopher, was the son of a rich merchant at Amiens, where he was born in 1620. He cultivated the languages and belles lettres in his own country, and then was sent to Paris to study philosophy. He seems to have been a great lover of truth, at least what he thought so, and to have sought it with much impartiality. He read the ancient and modern philosophers; but Des Cartes was the author who most engaged his attention. Accordingly he became a zealous follower of that great man, and drew up an abridgement and explanation of his philosophy with great clearness and method. In the preface to his Physics, for so his work is called, he makes no scruple to say, that "the abilities and accomplishments of this philosopher must oblige the whole world to confess, that France is at least as capable of producing and raising men versed in all arts and branches of knowledge, as ancient Greece." Clerselier, well known for his translation of many pieces of Des Cartes, conceived such an affection for Rohault, on account of his attachment to this philosopher, that he gave him his daughter in marriage against all the remonstrances of his family.

Rohault's Physics were written in French, but have been translated into Latin by Dr. Samuel Clarke, with notes, in which the Cartesian errors are corrected upon the Newtonian system. The fourth and best edition of Rohault's Physics, by Clarke, is that of 1718, in 8vo. He wrote also "Elemens de Mathematiques," "Traité de Mechanique," and "Entretiens sur la Philosophie." But these dialogues are founded and carried on upon the principles of the Cartesian philosophy which has now little other merit, than that of having corrected the errors of the ancients. Rohault died in 1675, and left behind him the character of an amiable, as well as a learned and philosophic man.

His posthumous works were collected and printed in two neat little volumes, first at Paris, and then at the Hague, in 1690. The contents of them are, 1. The first six books of Euclid. 2. Trigonometry. 3. Practical Geometry. 4. Fortification. 5. Mechanics. 6. Perspective. 7. Spherical Trigonometry. 8. Arithmetic.

ROLANDRA, in botany, so named in honour of Daniel Rolander, a pupil of Linnæus, who travelled to Surinam; a genus of the Syngénesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: florets bundled into a head with scales interposed; calyx partial, two-valved, one-flowered; corollets hermaphrodite; down none. There is but one species, *viz.* R. argentea, a native of the West Indies.

ROLLING *mill*, in mechanics, a machine for working metals into plates, or bars, which are required of an even thickness. In the Plate, Rolling-Mill, are three elevations of a machine for this purpose, A B, D E, in all these figures is a massive frame of cast iron, consisting of two distinct cheeks, A B and D E, which are connected together by being both affixed to an iron plate, F F, bolted down upon two ground sills, G G, supported on masonry, and forming the foundation for the whole machine; each cheek has an oblong mortice, *a b*, through it; a strong iron screw, *d*, is screwed through the upper end of each cheek, and has a wheel on the top of it, with teeth, to receive a handspike to turn it by. I K are the two rollers made of cast iron, and very truly turned in a lathe, they have pivots, *i l*, *k m*, at each end, turned at the

same time and with the greatest accuracy; these pivots are supported on bearings of brass, in the cheeks those of the lower roller, K, fit in the bottom of the mortices, *a b*, (fig. 1 and 3) through the cheeks, the upper ones, *e e*, are moveable, sliding up and down in the mortices by the action of the screw, *d*. The weight of the upper roller, when nothing is between the rollers, is sustained by an iron strap, *n*, at each end, embracing the pivots, and going through the brass bearing, *e e*. Its ends are tapped and have nuts screwed upon them to prevent their return through the ends of the collar, *p*, which fits in a groove cut round the screw, *d*, so that it cannot come off; the collar is made in two halves, which are held together by the ends of the strap, *n*, going through both at the place where they overlap each other; by this means the upper bearings are firmly connected with the screws to rise and fall with them; and at the same time, the pivots of the upper roller are held up to their bearings by the straps, *n*, going under them. The end of the pivots of the rollers are formed into squares beyond the bearings, and the pivots of one end of each roller have two cog wheels, L M, fitted on them, they are shown faceways (in fig. 1) and are both alike, they cause the two rollers to move with an equal velocity; the other square, *k*, on the lower roller, is fitted into a box, M, by which it is joined to a strong shaft, O, which communicates a rotatory motion to the rollers. This shaft receives its power from a water-wheel, steam-engine, horses, or other first moving power: *s* is a small trough made of iron plate, punched full of holes, it is supplied with water by a pipe, *n*, and constantly drops a small quantity of water upon the rollers, and thus keeps them cool when they are rolling hot work: *w*, is a bar of iron fixed between the two cheeks by wedges, the upper side is on a level with the top of the lower roller; a small distance above this is another iron bar, *x*, parallel to the former; between these the article intended to be rolled is introduced to the rollers.

Rolling mills are chiefly used for drawing out iron bars after they have been manufactured into bar iron by the forge hammer; the rollers leave a smoother surface, and make a bar of more even thickness than the hammer can be made to do; the iron hoops for barrels are also made in this machine; Its operation is exceeding simple, a furnace is placed close to the machine where the iron bars are to be rolled; are heated to a white heat; a workman stands between the furnace and the mill, and takes a bar from the furnace with a pair of pinchers, and puts its end between the bars, *w* and *x*, advancing it forwards until the rollers take it between them and draw it forwards, spreading it as it goes both in length and breadth; another workman, behind the machine, receives the bar as it comes through, and conveys it away to make room for the next. The small stream of water brought by the pipe, *r*, cools and hardens the iron as it is rolled without plunging in water. The rollers can be set nearer or further apart by turning the screws, *d d*, to make thicker or thinner work. The iron will pass through the rollers at the rate of three and a half or four inches per second, and thus will do a great quantity of work; but the power required to turn them, when they have large and heavy work in them, is immense; for the same reason the frame of the machine must be exceedingly strong and well put together.

ROLLS, are parchment, on which all the pleadings, memorials, and acts of courts are entered and filed with the proper officer, and then they become records of the court.

ROMAN *Catholics*, in church history, a name given to those christians who believe the doctrines and submit to the discipline of the church of Rome. They are also called Papists, from *papa*, father, because the Bishop of Rome is not only styled supreme, but œcumenical, or universal bishop; and they think they are entitled to the appellation of Catholics, because, as they assert, the Romish Church is not only *a* true church, but *the* only true church; having all the marks of the true church: viz. unity, holiness, universality, and apostolicity. Whether the Church of Rome has any exclusive right to these four assumed marks it is not our business to inquire.

The Roman or Latin Church is a system of government, whose jurisdiction extends to a great part of the known world; though its authority has been circumscribed within narrower limits since the era of the reformation; and has been, particularly of late years, gradually decaying in every country in Europe.

Of the origin of this most extraordinary power there are various accounts extant. It appears, however, that after the Roman Empire became christian, it was greatly corrupted, till the empire fell, and made way for the dominion and grandeur of the Bishop of Rome, under whom the corruption rose to an amazing height. Early in the

fourth century, in which the fathers, Cyril, Basil, Gregory, and Ambrose, flourished, was instituted the monastic life. Notwithstanding the piety and sanctity to which this institution made pretensions, a manifest love of power, and riches, was predominant; and that, at best, the monastic life laid the foundation of that superstructure of mystery, intolerance, and superstition, which in subsequent periods of the church made such havock with the peace and happiness of mankind. It was from this time that the church became modelled by assuming priests; the simplicity of truth was obscured by mystery; and the kingdom of Christ became a kingdom of this world. The popes, as bishops of Rome, having laid the foundation of that monarchical power to which they afterwards rose, one of the first and most essential steps was the creation of the dignity of Patriarch, afterwards confirmed by the Council of Nice. Thus the hierarchy became formed according to the constitution of the Roman empire. After this it was resolved that the precedence and authority of bishops over others should be determined by the rank of the cities where they resided; and of consequence in process of time, as it could be effected, the Bishop of Rome must have the supremacy; and this was managed with so much art, as to be confirmed in the next council, without its appearing previously to have been made a point of.

Constantine the Great, who became a christian, A. D. 312, took the cause of religion into his hands, and defended his new friends against the rage of their heathen adversaries with so much success, that he restored peace and tranquillity to the christian world. When the church, under this Emperor and his successors, enjoyed the protection of the civil powers, the christians began to compare their present with their past condition, and called to mind the sufferings of their predecessors, and the patience and fortitude which they had exerted, particularly in the last and severest persecution. These considerations raised in them a high, and indeed, in some degree a just veneration for the martyrs. But it did not stop here; what was at first only a pious veneration, soon rose into a kind of adoration; and it was discovered that considerable profit might be gained by the sale of bones and reliques that it were honourable, not to say miraculous, to possess, and meritorious to preserve. Athanasius and Gregory, Nazienzen and Chrysostom, used all their power and eloquence to increase the popular veneration and invocation of saints, the love of monkery, and the belief of miracles wrought by monks and reliques.

The period of intellectual vassalage now commenced; and trick and finese were soon discovered, by avaricious and ambitious priests, to be far more profitable than the truth as it is taught by Jesus.

It was about this time that the Council of Nice assembled, "by the grace of God, and favour of Constantine the prince, beloved of God," to crush by numbers, clamour, and authority, what proved too stubborn or too firm to yield to their arguments. By the arbitrary decision of three hundred and thirteen out of three hundred and eighteen bishops it was proved that the Son is consubstantial and of the same substance with the Father; and moreover that whosoever should dare to assert that this expression is unscriptural, he should, without further ceremony, be deemed a heretic, be cut off from communion with the church in this world, and without doubt should perish everlastingly in the world to come! After they had thus decided, and had banished Arius, and his followers, who determined to abide by the language of Scripture, these domineering priests sent letters of self-commendation to their friends in Egypt, Lybia, and Pentapolis. Having rewarded the priests, and recommended to them peace and harmony, Constantine dismissed the council, and wrote to several churches, recommending and enjoining universal conformity to the council's decrees, both in doctrines and ceremonies; using this, among other arguments, that what they had decreed was the will of God, and that the agreement of so great a number of bishops could be by no other than the immediate inspiration of the Holy Ghost. That the Nicene doctors were inspired, whoever considers the nature and extent of their anathemas and depositions, together with the subsequent persecutions, of which this council was the foundation, can have no doubt; whether their inspiration was by the Holy Ghost, is another question.

The scriptural christians, being now the weaker party, not relishing neither the decrees of the Nicene fathers, nor the letters of Constantine, most unhappy consequences very soon took place. The orthodox emperor, finding his admonitions disregarded, resolved, in the madness of his zeal, to try the efficacy of more forcible motives; and accordingly issued sundry edicts against all who should dare to oppose his will, or slight

the decrees of the Council of Nice; at the same time ordering that the books of their opponents should be burnt; and if any kept them in their possession, or endeavoured to counteract his edict, they should, on conviction thereof, suffer death.

Thus the authors of the Nicene Creed first brought in the punishment of heresy with death, and persuaded the emperor to destroy those whom he could not easily convert. The scriptures were now no longer the rule of faith and manners; but orthodoxy and heterodoxy were decided by vote, and agreed upon, not by the number and weight of arguments, but by the number and power of emperors, priests, and councils.

The next council that was held, was composed of bishops possessing opinions somewhat different from those of their predecessors, because Constantine II. happened to be favourable to the Arians. The side of orthodoxy was now changed; but fulminations and damnations still adhered to the decrees of the council against all those who should dare to oppose them. This alternate shifting of hands continued through the whole of this century. It was in this century also that painted crosses and the making of pilgrimages became fashionable.

The fifth century gave birth to an established union of the temporal and spiritual jurisdiction of the popes; though as yet no one had the hardihood to declare himself either infallible or supreme. The prohibiting priests to marry, baptizing with godfathers and godmothers, the sign of the cross in baptism, and some other less important matters, were introduced in this century.

The bulk of ecclesiastical historians fix the year 606 for the title of universal bishop, being conferred on the Pontiff of Rome. This dignity had been assumed by the Bishop of Constantinople in the preceding century, but was now confirmed to Boniface III.; who, being elected Pope, prevailed on the Emperor Phocas to take the title of universal bishop from the Bishop of Constantinople, and grant it to him, and his successors, by his absolute decree; which passed for that purpose.

Now it was that popery became established and general; from this period therefore we may date the appellation of Roman Catholic. Without however minutely detailing the origin of those various doctrines and ceremonies by which the Church of Rome has long been distinguished, we will proceed to give a succinct account of the belief and practice of this very large and respectable portion of the christian world. We cannot perhaps do this better than by laying before the reader

A Summary of the Doctrine, Discipline, and Ceremonies of the Church of Rome, as contained in Pope Pius IV.'s Creed.

"Art. I. I believe in one God, the Father Almighty, maker of heaven and earth, and of all things visible and invisible. The one true and living God in three persons, Father, Son, and Holy Ghost.

"II. I believe in one Lord Jesus Christ, the only-begotten Son of God, begotten of the Father before all worlds, God of God, light of light, very God of very God, begotten not made, being of one substance with the Father, by whom all things were made.

"III. Who for us men, and for our salvation, came down from heaven, and was incarnate of the Holy Ghost of the Virgin Mary, and was made man.

"IV. And was crucified also for us under Pontius Pilate; he suffered and was buried.

"V. And the third day rose again, according to the scriptures.

"VI. He ascended into heaven, sits at the right hand of the Father.

"VII. And is to come again with glory to judge both the living and the dead, of whose kingdom there shall be no end.

"VIII. I believe in the Holy Ghost, the Lord and giver of life, who proceeds from the Father and the Son, who with the Father and the Son is adored and glorified; who spake by the prophets.

"IX. I believe in one, holy, catholic, and apostolic church.

"X. I acknowledge one baptism for the remission of sins.

"XI. I look for the resurrection of the dead.

"XII. I believe in the life of the world to come. Amen.

"XIII. I most firmly admit and embrace the apostolical and ecclesiastical traditions, and all other observations and constitutions of the same church.

"XIV. I do admit the holy scriptures in the same sense that Holy Mother Church doth, whose business it is to judge of the true sense and interpretation of them, and I will interpret them according to the unanimous consent of the fathers.

"XV. I do profess and believe that there are seven sacraments, truly and properly so called, instituted by Jesus Christ our

Lord, and necessary for the salvation of mankind, though not all of them to every one, *viz.* baptism, confirmation, eucharist, penance, extreme unction, orders, and matrimony; and that they do confer grace; and that of these, baptism, confirmation, and orders, cannot be repeated without sacrilege. I also receive and admit the received and approved rites of the catholic church, in her solemn administration of all the aforesaid sacraments.

"XVI. I embrace and receive every thing that hath been defined and declared by the holy Council of Trent, concerning original sin and justification.

"XVII. I do also profess, that in the mass there is offered unto God a true, proper, and propitiatory sacrifice for the quick and the dead; and that, in the most holy sacrament of the eucharist, there is truly, really, and substantially the body and blood, together with the soul and divinity of our Lord Jesus Christ; and that there is a conversion made of the whole substance of the bread into the body, and of the whole substance of the wine into the blood; which conversion the whole Catholic church call Transubstantiation.

"XVIII. And I believe, that under one kind only, whole and entire, Christ is taken and received.

"XIX. I do firmly believe, that there is a purgatory, and that the souls kept prisoners there do receive help by the suffrage of the faithful. That the souls of the patriarchs and holy men, who departed this life before the crucifixion of Christ, were kept as in prison, in an apartment of hell, without pain. That Christ did really go into local hell, and delivered the captive souls out of this confinement. The fathers assert, that our Saviour descended into hell, went thither specially, and delivered the souls of the fathers out of that mansion.

"XX. I do believe that the saints reigning together with Christ are to be worshipped and prayed unto, and that they do offer prayers unto God for us, and that their relics are to be had in veneration.

"XXI. I do firmly believe, that the images of Christ, of the blessed Virgin, the mother of God, and of other saints, ought to be had and retained, and that due honour and veneration ought to be paid unto them.

"XXII. I do affirm, that the power of indulgences was left by Christ in the church, and that the use of them is very beneficial to Christian people.

"XXIII. I do acknowledge the holy catholic and apostolic Roman church to be the mother and mistress of all churches: and I do promise and swear true obedience to the Bishop of Rome, the successor of St. Peter, the prince of the apostles, and vicar of Jesus Christ.

"XXIV. I do undoubtedly receive and profess all other things that have been delivered, defined, by the sacred canons and oecumenical councils, and especially by the holy synod of Trent; and all other things contrary hereunto, and all heresies condemned, rejected, and anathematised, by the church, I do likewise condemn, reject, and anathematise."

This bull, as it is called, bears date on the ides of November, 1564, and concludes in the usual manner, with threats of the indignation of God, and of his blessed apostles St. Peter and St. Paul, against all who dare to infringe or oppose it. Whether this profession of faith would now be subscribed by every Roman Catholic, we will not take upon us to say; but it is certain, that it has received the sanction and confirmation of the council of Trent, the last general council, and has been explained and vindicated by Bossuet and other Catholic writers. We should not omit to notice the truly ingenious publication of the late worthy Dr. Alexander Geddes, entitled "A Modest Apology for the Roman Catholics of Great Britain." In this singular publication, the author has laboured hard to prove that a very great resemblance exists (even so much so as to leave little to prevent a cordial coalition), between the doctrines and discipline of the two churches of Rome and of England. This dissenting Catholic seems to speak of the Romish Church in terms not much like what her friends have usually employed on similar occasions; and very plainly informs us, that the enervation of ancient church discipline; the fabrication of false decretals; the multiplication of appeals, dispenses, exemptions, immunities, and enormous privileges; the rage of idle pilgrimages; the base traffic of indulgences; the propagation of lying legends, feigned miracles, and apocryphal revelations; the doctrines of the Pope's infallibility, temporal jurisdiction, and deposing power, are so many large crops of spiritual cockle, that have been, at different times, "while men slept," sown by the enemy in the wide field of the Catholic world. This representation is certainly curious, at least, as coming from the pen of a professed Roman Catholic priest. If the English Catholics differ materially from their brethren in other coun-

tries, where is the unity and catholicity of the Romish faith?

We must now conclude this article with a brief statement of the decline and present state of the papal power in Europe.

The deadly blow which this gigantic power received in the sixteenth century we have already treated of in the article REFORMATION.

From the effects of that blow the Roman Catholic interests have never yet recovered. It was a deep and deadly wound to the usurpations of tyranny and the towering pride of ecclesiastical domination. In the article to which we have already alluded, the reader will find a brief enumeration of the countries which received the doctrines of the reformation, as well also of those countries where the principles of religious liberty had made but little progress. These latter were principally France, Spain, Italy, and Poland. In each of these countries the spirit of reform has, more or less, manifested itself since the era of the reformation. In the first of these countries particularly, the authority of the supreme head of the church has, since the commencement of the revolution, received an alarming diminution. Indeed, the liberties of the Gallican church had always depended upon two maxims: 1. That the Pope has not authority to command any thing in general or particular, in which the civil rights of the kingdom are concerned. 2. That though the Pope's supremacy is owned in spiritual matters; yet his power is limited and regulated by the decrees and canons of ancient councils in the realm. These maxims in the Gallican church have been superseded by the Concordat; and still more by events of a very recent date. When the French revolution first broke out, the clergy in that country suffered every species of insult and cruelty that an infuriate rabble or more refined councils could invent. Their tythes and revenues were taken from them, and the possessions of the church were considered as national property. The religious orders were dissolved, and their estates confiscated. When the National Assembly attempted to impose upon the clergy what they denominated The civil constitution of the clergy, a refusal to submit to it, and to that of taking an oath to maintain it, was attended with the most alarming consequences. One hundred and thirty-eight bishops and archbishops, and sixty-eight curates, or vicars, were on this account driven from their sees and parishes. Numbers of these unfortunate men were massacred in the streets, while hundreds of them sought refuge in this and other countries. Notwithstanding these proceedings, on the 28th of May, 1795, a decree was obtained for the freedom of religious worship; and on the following June the churches in Paris were re-opened, and divine service was again performed with great ceremony. The clergy have never since been molested in France; but their power and influence were greatly diminished, for though the Modereès, or Brissotine party, recalled them, no establishment was made for them, until Bonaparte, as First Consul, procured the Pope's consent to the Concordat, which the old Catholics assert surrendered all their rights and privileges of the church to the secular head.

By degrees the Pope of Rome has continued to lose his influence in France. The number of Catholic clergy is now very considerably reduced; and all the religious orders in France, the Sisters of Charity excepted, are abolished, together with all public processions, pilgrimages, &c. The French General, Bonaparte, drove the late Pope, Pius VI., from Rome, and compelled him to take shelter in a Carthusian monastery, about two miles from Florence, where he died, August 19th, 1799. The French army who took possession of Rome, made no ceremony in abolishing many of those rites which for centuries had been regarded as sacred. A new Pope, however, has been elected, who has taken the name of Pius VII. This pontiff at present resides at Rome, the seat of his ancestors, and has often officiated in the Vatican. But his power is gone, probably for ever. Bonaparte has lately seized on his temporal dominions, and driven his friends and counsellors, the Cardinals, from his presence. On the 19th of April, 1808, a most curious and interesting state paper was published by the Pope, entitled "Anwer of his Eminence Cardinal Gabrielli, first Secretary of State, to the Note of his Excellency M. Champagny, addressed to M. Le Fevre, Charge d'Affaires from the Emperor of France." We lament that our limits will not permit us to preserve the whole of this curious document in our pages. We may however, remark, that this paper is in answer to a demand which the French ruler had made upon his Holiness, to enter into an offensive and defensive league with the other powers of Italy, against all the enemies of France, and also that the Pope should dismiss from his court the Cardinals. To these demands his Holiness replies in a spirited but highly pathetic strain. He

declares in one part of his paper, that "His Holiness, unlike other princes, is invested with a two-fold character, namely, of Sovereign Pontiff, and of Temporal Sovereign, and has given repeated evidence that he cannot, by virtue of this second qualification, enter upon engagements which would lead to results militating against his first and most important office, and injuring the religion of which he is the head, the propagator, and the avenger."

The French Emperor had declared, that in case the Pope would not accede to his demands, he would seize upon the temporal dominions of the Holy See. To which his Holiness replies, that "If, in spite of all this, his Majesty shall take possession, as he has threatened, of the papal dominions, respected by all even the most powerful monarchy, during a space of ten centuries and upwards, and shall overturn the goverment, his Holiness will be unable to prevent this spoliation; and can only in bitter affliction of heart, lament the evil which his Majesty will commit in the sight of God, trusting in whose protection, his Holiness will remain in perfect tranquillity, enjoying the consciousness of not having brought on this disaster by imprudence or by contumacy, but to preserve the independence of that sovereignty which he ought to transmit uninjured to his successors, as he received it; and to maintain in its integrity, that conduct which may secure the universal concurrence of all princes, so necessary to the welfare of religion." What the final result of these negotiations will be time only can determine; this, however, is certain, at present, that the Roman Pontiff has lost his power and authority in France. Nor are his prospects much more favourable in other countries. There is scarcely a Catholic State in Europe that does not every year relax in its observance of the Romish laws, and in obedience to the Holy See. The terrors of the Inquisition no longer exist; the thunders of the Vatican are ceased or disregarded; some of the most offensive maxims of popery are not only destroyed by the liberal spirit of the times, but even publicly disavowed by numerous and respectable bodies of Catholics: in short, little now remains of the Romish faith and practice, especially in our own country, that ought to give serious offence to liberal Protestants of the Church of England; there is indeed nothing remaining among these people of a nature dangerous to the peace and happiness of the community at large.

The question concerning the Catholic Emancipation in this country and in Ireland, being as yet undecided, we must omit any further notice of it; at the same time most ardently longing that the period may soon commence, when no difference of opinion whatever, no variation in our worship, shall prove a barrier to the full exercise of all those rights, both civil and religious, to which all men are born, and to which all good and peaceable men have an equal claim. See PAPISTS.

RONDELETIA, in botany, so named in honour of Guilleaume Rondelet, a famous physician and natural historian, of Montpelier; a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla funnel-shaped; capsule two-celled, inferior, many-seeded, roundish, crowned. There are fourteen species.

ROOD, a quantity of land equal to forty square perches, or the fourth part of an acre.

ROOT, in mathematics, a quantity considered as the basis or foundation of a higher power; or one which, being multiplied into itself any number of times, produces a square, cubic, biquadratic, &c. quantity; called the second, third, fourth, &c. power of the root, or quantity, so mutiplied into itself: thus a is the square root of $a \times a$, or a^2; and 4 the square root of $4 \times 4 = 16$. Again, a is the cube root of $a \times a \times a = a^3$: and 3 the cube root of $3 \times 3 \times 3 = 27$: and so on. The roots of powers are expressed by placing the radical sign $\sqrt{}$ over them, with a number denoting what kind of root they are: thus the square or second root of 16 is expressed by $\sqrt[2]{16}$, and the cube or third root of 27 by $\sqrt[3]{27}$; and, in general, the n^{th} root of a, raised to the power, m, is expressed by $\sqrt[n]{a^m}$. When the root of a compound quantity is wanted, the vinculum of the radical sign must be drawn over the whole: thus the square root of $a^2 + 2ab + b^2$ is expressed by $\sqrt[2]{a^2 + 2ab + b^2}$; and it ought to be observed, that when the radical sign has no number above it, to denote what root is wanted, the square root is always meant; as $\sqrt{a^2}$, or $\sqrt{16}$, is the square root of a^2, or the square root of 16.

ROPE, hemp, hair, &c. spun into a thick yarn, and then several strings of this yarn twisted together by means of a wheel. When made very small, it is called a cord, and when very thick, a cable. All the different kinds of this manufacture, from a

fishing-line, or whip-cord, to the cable of a first-rate ship of war, go by the general name of cordage. Ropes are made of every substance that is sufficiently fibrous, flexible, and tenacious, but chiefly of the inner barks of plants. The Chinese, and other orientals, even make them of the ligneous parts of several plants, such as certain bamboos and reeds, the stems of the aloes, the fibrous covering of the cocoa-nut, the filaments of the cotton pod, and the leaves of some grasses. But the barks of plants are the most productive of fibrous matter, fit for this manufacture. Those of the linden-tree, of the willow, the bramble, the nettle, are frequently used; but hemp and flax are the best; and of these, the hemp is preferred, and employed in all cordage exceeding the size of a line, and even in many of this denomination. Hemp is very various in its useful qualities; the best in Europe comes to us through Riga, to which port it is brought from very distant places southward.

Rope *making*, is an art of very great importance; and there are few that better deserve the attention of the intelligent observer. Hardly any art can be carried on without the assistance of the rope-maker. Cordage makes the very sinews and muscles of a ship; and every improvement which can be made in its preparation, either in respect to strength or pliableness, must be of immense service to the mariner, and to the commerce and the defence of nations. The aim of the rope-maker is to unite the strength of a great number of fibres, and the first part of his process is spinning of rope-yarns, that is, twisting the hemp in the first instance. This is done in various ways, and with different machinery, according to the nature of the intended cordage. We shall confine our description to the manufacture of the larger kinds, such as are used for the standing and running rigging of ships. An alley, or walk, is inclosed for the purpose, about two hundred fathoms long, and of a breadth suited to the extent of the manufacture. It is sometimes covered above. At the upper end of this rope-walk is set up the spinning-wheel. The band of the wheel goes over several rollers, called whirls, turning on pivots in brass holes. The pivots at one end come through the frame, and terminate in little hooks. The wheel, being turned by a winch, gives motion in one direction to all those whirls. The spinner has a bundle of dressed hemp round his waist, with the two ends meeting before him. The hemp is laid in this bundle in the same way that women spread the flax on the distaff. There is great variety in this; but the general aim is to lay the fibres in such a manner, that as long as the bundle lasts, there may be an equal number of the ends at the extremity, and that a fibre may never offer itself double, or in a bight. The spinner draws out a proper number of fibres, twists them with his fingers, and having got a sufficient length detached, he fixes it to the hook of a whirl. The wheel is now turned, and the skein is twisted, becoming what is called rope-yarn, and the spinner walks backwards down the rope-walk. The part already twisted, draws along with it more fibres out of the bundle. The spinner aids this with his fingers, supplying hemp in due proportion as he walks away from the wheel, and taking care that the fibres come in equally from both sides of his bundle, and that they enter always with their ends, and not by the middle, which would double them. He should also endeavour to enter every fibre at the heart of the yarn. This will cause all the fibres to mix equally in making it up, and will make the work smooth, because one end of each fibre is by this means buried among the rest, and the other end only lies outward; and this, in passing through the grasp of the spinner, who presses it tight with his thumb and palm, is also made to lie smooth. A good spinner endeavours always to supply the hemp in the form of a thin flat skein, with his left hand, while his right is employed in grasping firmly the yarn that is twining off, and in holding it tight from the whirl, that it may not run into loops or kinks. It is evident, that both the arrangement of the fibres, and the degree of twisting, depend on the skill and dexterity of the spinner, and that he must be instructed, not by a book, but by a master. The degree of twist depends on the rate of the wheel's motion, combined with the retrograde walk of the spinner. We may suppose him arrived at the lower end of the walk, or as far as is necessary for the intended length of his yarn. He calls out, and another spinner immediately detaches the yarn from the hook of the whirl, gives it to another, who carries it aside to the reel; and this second spinner attaches his own hemp to the whirl-hook. In the mean time, the first spinner keeps fast hold of the end of his yarn; for the hemp, being dry, is very elastic, and if he were to let it go out of his hand, it

would instantly untwist, and become little better than loose hemp. He waits, therefore, till he sees the reeler begin to turn the reel, and he goes slowly up the walk, keeping the yarn of an equal tightness all the way, till he arrives at the wheel, where he waits with his yarn in his hand till another spinner has finished his yarn. The first spinner takes it off the whirl-hook, joins it to his own, that it may follow it on the reel, and begins a new yarn. The second part of the process is the conversion of the yarns into what may, with propriety, be called a rope, cord, or line. That we may have a clear conception of the principle which regulates this part of the process, we shall begin with the simplest possible case, the union of two yarns into one line.

When hemp has been split into very fine fibres by the hatchel, it becomes exceedingly soft and pliant, and after it has lain for some time in the form of fine yarn, it may be unreeled and thrown loose, without losing much of its twist. Two such yarns may be put on the whirl of a spinning wheel, and thrown like flaxen yarn, so as to make sewing thread. It is in this way, indeed, that the sailmakers sewing thread is manufactured, and when it has been kept on the reel, or on balls or bobbins for some time, it retains its twist as well as its uses require. But this is by no means the case with yarns spun for great cordage. The hemp is so elastic, the number of fibres twisted together is so great, and the diameter of the yarn (which is a sort of lever on which the elasticity of the fibre exerts itself), is so considerable, that no keeping will make the fibres retain this constrained position.

The end of a rope-yarn being thrown loose, it will immediately untwist, and this with considerable force and speed. It would, therefore, be a fruitless attempt to twist two such yarns together; yet the ingenuity of man has contrived to make use of this very tendency to untwist not only to counteract itself, but even to produce another and a permanent twist, which requires force to undo it, and which will recover itself when this force is removed. Every person must recollect that when he had twisted a packthread very hard with his fingers between his two hands, if he slackens the thread by bringing his hands nearer together, the packthread will immediately curl up, running into loops or kinks, and will even twist itself into a neat and firm cord. The component parts of a rope are called strands, and the operation of uniting them with a permanent twist is called laying or closing, the latter term being chiefly appropriated to cables and other very large cordage.

The process for laying or closing large cordage is this: the strands of which the rope is composed consist of many yarns, and require a considerable degree of hardening. This cannot be done by a whirl driven by a wheel-band; it requires the power of a crank turned by the hand. The strands, when properly hardened, become very stiff, and when bent round the top, are not able to transmit force enough for laying the heavy and unpliant rope which forms beyond it. The elastic twist of the hardened strands must, therefore, be assisted by an external force. All this requires a different machinery and a different process. At the upper end of the walk is fixed up the tackle-board, this consists of a strong oaken plank, called a breast-board, having three or more holes in it, fitted with brass or iron plates. Into these are put iron cranks, called heavers, which have hooks or forelocks, and keys, on the ends of their spindles. They are placed at such a distance from each other, that the workmen do not interfere with each other while turning them round. This breast board is fixed to the top of strong posts, well secured by struts, or braces, facing the lower end of the walk. At the lower end is another breast-board, fixed to the upright post of a sledge, which may be loaded with stones or other weights. Similar cranks are placed in the holes of this breast-board; the whole goes by the name of the sledge. The top necessary for closing large cordage is too heavy to be held in the hand; it therefore has a long staff, which has a truck on the end: this rests on the ground, but even this is not enough in laying great cables. The top must be supported on a carriage, where it must lie very steady, and it needs attendance, because the master workman has sufficient employment in attending to the manner in which the strands close behind the top, and in helping them by various methods. The top is therefore fixed to the carriage, by lashing its staff to the two upright posts. A piece of soft rope, or strap, is attached to the handle of the top by the middle, and its two ends are brought back and wrapped several times tight round the rope, in the direction of its twist, and bound down. This greatly assists the laying of the rope

by its friction, which both keeps the top from flying too far from the point of union of the strands, and brings the strands more regularly into their places. The first operation is warping the yarns. At each end of the walk are frames called warping frames, which carry a great number of reels or winches, filled with rope-yarn. The foreman of the walk takes off a yarn end from each, till he has made up the number necessary for his rope or strand, and bringing the ends together, he passes the whole through an iron ring fixed to the top of a stake driven into the ground, and draws them through: then a knot is tied on the end of the bundle, and a workman pulls it through this ring till the intended length is drawn off the reels. The end is made fast at the bottom of the walk, or at the sledge, and the foreman comes back along the skein of yarns, to see that none are hanging slacker than the rest. He takes up in his hand such as are slack, and draws them tight, keeping them so till he reaches the upper end, where he cuts the yarns to a length, again adjusts their tightness, and joins them altogether in a knot, to which he fixes the hook of a tackle, the other block of which is fixed to a firm post, called the warping post. The skein is well stretched by this tackle, and then separated into its different strands. Each of these is knotted apart at both ends. The knots at their upper ends are made fast to the hooks of the cranks in the tackle-board, and those at the lower ends are fastened to the cranks in the sledge. The sledge itself is kept in its place by a tackle, by which the strands are again stretched in their places, and every thing adjusted, so that the sledge stands square on the walk, and then a proper weight is laid on it. The tackle is now cast off, and the cranks are turned at both ends, in the contrary direction to the twist of the yarns (in some kinds of cordage the cranks are turned the same way with the spinning twist). By this the strands are twisted and hardened up, and as they contract by this operation, the sledge is dragged up the walk. When the foreman thinks the strands sufficiently hardened, which he estimates by the motion of the sledge, he orders the heavers at the cranks to stop. The middle strand at the sledge is taken off from the crank; this crank is taken out, and a stronger one put in its place. The other strands are taken off from their cranks, and are all joined on the hook which is now in the middle hole; the top is then placed between the strands, and being pressed home to the point of their union, the carriage is placed under it, and it is firmly fixed down: some weight is taken off the sledge. The heavers now begin to turn at both ends; those at the tackle-board continue to turn as they did before, but the heavers at the sledge turn in the opposite direction to their former motion, so that the cranks at both ends are now turning one way. By the motion of the sledge-crank the top is forced away from the knot, and the rope begins to close. The heaving at the upper end restores to the strand the twist which they are constantly losing by the laying of the rope. The workmen judge of this by making a chalk mark on intermediate points of the strands, where they lie on the stakes which are set up along the walk for their support. If the twist of the strands is diminished by the motion of closing, they will lengthen, and the chalk mark will move away from the tackle-board; but if the twist increases by turning the cranks at the tackle-board, the strands will shorten, and the mark will come nearer to it. As the closing of the rope advances, the whole shortens, and the sledge is dragged up the walk. The top moves faster, and at last reaches the upper end of the walk, the rope being now laid.

In the mean time, the sledge has moved several fathoms from the place where it was when the laying began. These motions of the sledge and top must be exactly adjusted to each other. The rope must be of a certain length, therefore the sledge must stop at a certain place. At that moment the rope should be laid; that is, the top should be at the tackle-board. In this consists the address of the foreman. He has his attention directed both ways. He looks at the strands, and when he sees any of them hanging slacker between the stakes than the others, he calls to the heavers at the tackle-board to heave more upon that strand. He finds it more difficult to regulate the motion of the top. It requires a considerable force to keep it in the angle of the strands, and it is always disposed to start forward. To prevent or check this, some straps of soft rope are brought round the staff of the top, and then wrapped several times round the rope behind the top, and kept firmly down by a lanyard or bandage. This both holds back the top, and greatly assists the laying of the rope, causing the strands to fall into their places, and keep close to each other,

which is sometimes very difficult, especially in ropes composed of more than three strands. It will greatly improve the laying the rope, if the top has a sharp, smooth, tapering pin of hard wood, pointed at the end, projecting so far from the middle of its smaller end, that it gets in between the strands which are closing. This supports them, and makes their closing more gradual and regular. The top, its notches, the pin, and the warp, or strap, which is lapped round the rope, are all smeared with grease or soap, to assist the closing. The foreman judges of the progress of closing chiefly by his acquaintance with the walk, knowing that when the sledge is abreast of a certain stake, the top should be abreast of a certain other stake. When he finds the top too far down the walk, he slackens the motion at the tackle-board, and makes the men turn briskly at the sledge. By this the top is forced up the walk, and the laying of the rope accelerates, while the sledge remains in the same place, because the strands are loosing their twist, and are lengthening, while the closed rope is shortening. When, on the other hand, he thinks the top too far advanced, and fears that it will be at the head of the walk before the sledge has got to its proper place, he makes the men heave briskly on the strands, and the heavers at the sledge-crank work softly. This quickens the motion of the sledge by shortening the strands; and by thus compensating what has been over-done, the sledge and top come to their places at once, and the work appears to answer the intention. When the top approaches the tackle-board, the heaving at the sledge could not cause the strands immediately behind the top to close well, without having previously produced an extravagant degree of twist in the intermediate rope. The effort of the crank must therefore be assisted by men stationed along the rope, each furnished with a tool called a woolder. This is a stout oaken stick, about three feet long, having a strap of soft rope-yarn or cordage, fastened on its middle or end. The strap is wrapped round the laid rope, and the workman works with the stick as a lever, twisting the rope round in the direction of the crank's motion. The woolders should keep their eye on the men at the crank, and make their motion correspond with his. Thus they send forward the twist produced by the crank, without either increasing or diminishing it, in that part of the rope which lies between them and the sledge. Such is the general and essential process of rope-making. The fibres of hemp are twisted into yarns, that they may make a line of any length, and stick among each other with a force equal to their own cohesion. The yarns are made into cords of permanent twist by laying them; and that we may have a rope of any degree of strength, many yarns are united in one strand, for the same reason that many fibres were united in one yarn; and in the course of this process it is in our power to give the rope a solidity and hardness which make it less penetrable by water, which would rot it in a short while. Some of these purposes are inconsistent with others; and the skill of a rope-maker lies in making the best compensation, so that the rope may on the whole be the best in point of strength, pliancy, and duration, that the quantity of hemp in it can produce. The following rule for judging of the weight which a rope will bear is not far from the truth. It supposes them rather too strong; but it is so easily remembered, that it may be of use. Multiply the circumference in inches by itself, and take the fifth part of the product, it will express the tons which the rope will carry. Thus, if the rope has six inches circumference, 6 times 6 is 36, the fifth of which is $7\frac{1}{5}$ tons.

ROPE *yarn*, among sailors, is the yarn of any rope untwisted, but commonly made up of junk; its use is to make sinnet, mats, &c.

RORIDULA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-leaved; corolla five-petalled; anthers scrotiform at the base; capsule three-valved. There is but one species, *viz.* R. dentata, a native of the Cape of Good Hope.

ROSA, in botany, the *rose*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Calyx pitcher-shaped, five-cleft, fleshy, contracted at the neck; petals five; seeds very many, hispid, fastened to the inner side of the calyx. There are forty species.

ROSACIC *acid*. During certain diseases, the urine, when it cools, deposits a peculiar substance, which has been denominated, from its colour, which resembles bricks, lateritious sediment. During fevers, this appearance of the urine takes place; and in gouty persons, at the termination of the paroxysms, it is very abundant. And when this suddenly disappears, and the urine at

the same time continues to deposit this substance, a relapse may be dreaded. It appears in the form of red flakes, and adheres strongly to the sides of the vessel. If the urine be heated, this sediment is again dissolved. This substance was formerly considered by chemists as the uric acid. If into fresh urine, a little nitric acid is dropped, it becomes muddy, and a precipitate is formed. The nitric acid, and the substance to which the name of rosacic acid has been given, combine together, and are deposited. The uric acid, being much less soluble than the rosacic acid, it is very easy to separate them. All that is necessary is, to pour boiling water on the sediments, and to wash them on the same filter, in which case, the uric acid remains behind.

ROSMARINUS, in botany, a genus of the Diandria Monogynia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: corolla unequal, with the upper-lip two-parted; filaments long, curved, simple, with a tooth. There are two species, *viz.* R. officinalis, officinal rosemary; and R. chilensis, Chili rosemary.

ROTACEÆ, in botany, the name of the twentieth order in Linnæus's Fragments of a Natural Method, consisting of plants with one flat, wheel-shaped petal. Among the genera of this order is the gentiana, the root of which is a well-known stomachic, and makes a principal ingredient in bitters. The plant grows plentifully in the mountainous parts of Germany, from whence the roots are brought to England for medicinal purposes. The cistus, or rock-rose, and the hypincum, or St. John's wort, have been annexed also to this order. It may be observed, that gum labdanum is an odoriferous balsam, or resin, which is found on a species of the rock-rose, *viz.* the cistus ladanifera, that grows naturally in the Levant. This substance is collected by the natives by means of leathern thongs, rubbed gently over the surface of the shrub which produces it. From a species of the hypericum, an oil is extracted, that proves an excellent vulnerary.

ROTALA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Caryophylleæ. Essential character: calyx three-toothed; corolla none; capsule three-celled, many-seeded. There is but one species, *viz.* R. verticillaris, a native of the East Indies.

ROTATION, in geometry, a term chiefly applied to the circumvolution of any surface round a fixed and immoveable line, which is called the axis of its rotation: and by such rotations it is, that solids are conceived to be generated. The late ingenious M. de Moivre shows how solids, thus generated, may be measured or cubed. His method is this: for the fluxion of such solids, take the product of the fluxion of the absciss, multiplied by the circular base; and, suppose the ratio of a square to the circle inscribed in it to be $\frac{n}{1}$: then the equation expressing the nature of any circle, whose diameter is d, is $yy = dx - xx$. Therefore $\frac{4dx\dot{x} - x^2 x}{n}$ is the fluxion of a portion of the sphere; and, consequently, the portion itself $4\frac{1}{2}dxx - x\frac{1}{3}x^3$, and the circumscribed cylinder is $\frac{4dxx - x^3}{n}$; and therefore the portion of the sphere is to the portion of the circumscribed cylinder, as $\frac{1}{2}d - \frac{1}{3}x$ to $d - x$.

ROTHIA, in botany, so named in honour of Albrecht Wilhelm Roth, physician at Bremen; a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx many-leaved, in a single row, equal, woolly; receptacle in the ray chaffy, in the disk villose; seeds in the ray bald, in the disk pappose. There is only one species, *viz.* R. andryaloides.

ROTTBOELLIA, in botany, so named in memory of Christian Früs Rottboel, Professor of Botany, at Copenhagen; a genus of the Polygamia Monoecia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: rachis jointed, roundish, in most species filiform; calyx ovate, lanceolate, flat, one or two-valved; florets alternate on a flexuose rachis. There are seventeen species.

ROUND, in a military sense, signifies a walk which some officer, attended with a party of soldiers, takes in a fortified place around the ramparts, in the night-time, in order to see that the centries are watchful, and every thing in good order. The centries are to challenge the rounds at a distance, and rest their arms as they pass, to let none come near them; and when the round comes near the guard, the centry calls aloud, "Who comes there?" and being answered, "the rounds;" he says "stand;" and then calls the corporal of the guard, who draws his sword, and calls also, "Who comes there;" and when he is an-

swered, "the rounds," he who has the word advances, and the corporal receives it with his sword pointed to the giver's breast. In strict garrison, the rounds go every quarter of an hour

ROUSSEA, in botany, so named in memory of the celebrated Jean Jacques Rousseau; a genus of the Tetrandria Monogynia class and order. Essential character; calyx four-leaved; corolla one-petalled, bell-shaped, four-cleft, inferior; berry quadrangular, many-seeded. There is but one species, *viz.* R. simplex, this is a small climbing shrub, found by Commerson in the island of St. Mauritius.

ROXBURGHIA, in botany, so named in honour of William Roxburgh, M. D; a genus of the Octandria Monogynia class and order. Essential character: calyx four-leaved; corolla four-petalled, inwardly keeled; nectary four, awl-shaped; leaflets on the apex of the keel of the petals, converging; anthers linear, sessile in the grooves of the keel; capsule one-celled, two-valved; seeds many, inserted in a spongy receptacle. There is but one species, *viz.* R. gloriofoides, a native of Coromandel, in moist valleys, between the mountains, flowering in the cold season. It is the Canipoo Tiga of the Telingas.

ROYALTIES, are the rights of the King. See PREROGATIVE.

ROYAL *Exchange.* The term royal, applied to the Exchange of London, originated with Queen Elizabeth, a princess who, though tinctured with the arbitrary prejudices of her time, deserves the grateful remembrance of her countrymen for many wise and extremely beneficial acts, equally contributing to increase the political and commercial prosperity of England.

The word Exchange is certainly improperly applied to a building in which the act of exchanging or bartering takes place; but we are not the only people who thus misuse the appellation, as many towns on the Continent have their Places de Change. We know nothing more of the Bourse (synonimous with Exchange) frequented by the merchants of London before the reign of Elizabeth, except that it was situated in Lombard Street. It is, however, reasonable to suppose, that it was too inconsiderable in its extent, or had become ruinous by that period, as Sir Thomas Gresham then entertained thoughts of exerting his influence to render his fellow-citizens an essential service, and at the same time improve his own property.

It is singular, that a people celebrated for their commercial enterprize from the very foundation of their metropolis, should have proceeded through many centuries contented with transacting their business at casual and uncertain meetings, when it seems so obvious to their posterity that a rallying point is absolutely necessary where a trader may, at a fixed and certain hour, see and converse with those connected with him in commerce, and meet with purchasers for his commodities.

There cannot exist a doubt, that numbers of the citizens of London felt the necessity for an established and convenient Exchange, which may be supposed from the first attempt made in Lombard Street, and which might have suggested the plan afterwards executed by Gresham, whose very extensive concerns made him more particularly sensible of the deficiencies of London in this instance. The circumstances attending the founding of the original Exchange on the present scite, has contributed to convey all the honour of the undertaking to Sir Thomas, when, in truth, he was only an active partner in that honour; as it is an indisputable fact, that the Corporation of London purchased, at the expense of the city, not less than eighty houses, and the ground on which they stood, for the sum of four thousand pounds: these they ordered to be taken down, and the earth prepared for building a magnificent structure.

It will be perceived from this statement, that the collective body of the citizens was by no means deficient in their wishes to second the views of Gresham, who engaged to erect the Exchange at his own expense, and the parties were mutually to enter into conveyances of the ground and building to each other, that their descendants and successors might for ever possess a joint and equal property in the subsequent profits of the concern. This covenant was faithfully complied with by the Corporation, but Sir Thomas neglected to execute his part of it. Hence, it must be admitted, that the latter has no claim to the exclusive gratitude of the natives of London; on the contrary, it is very evident, the patriotism of the act should be divided between the then Lord Mayor, Alderman, and Council, and Gresham; with this admission in his favour, that it is more than probable the Corporation would never of themselves have conferred an Exchange on the city they governed.

Sir Thomas laid the first stone of the edifice on the seventh day of June, 1566, which

was completed with brick, and so contrived as to render the reimbursement of his expenses as certain as human foresight would permit. This he supposed might be accomplished by the fines and rents accruing from a very considerable number of vaults, and shops which inclosed the area intended for the ostensible purposes of the building. The novelty of this arrangement operated greatly in his favour, and the shops let rapidly; but the vaults, as our ancient writers term them, being partly under ground, and consequently equally dark and damp, were but partially occupied. Sensible of his mistake, and determined to retrieve it if possible, he resolved that his future tenants should take the vaults with the shops at eight marks per annum; and they proceeded thus for some time, till at length it was fully ascertained the public would not be compelled to descend to purchase commodities in the dark. The tenants, therefore, unanimously resolved to offer him four pounds per annum for the shop only, resigning all claims to the vaults. This the knight immediately accepted, and let them to merchants for the reception of packages, and large quantities of pepper, which article is still deposited in those of the present building.

While the projector of the Exchange employed every engine to increase his profits on its erection, neither himself nor his colleagues were inattentive to its original purpose; and they considered, that though it was impossible the merchants and traders of the city, and the foreigners who visited it, should not perceive the advantages it offered them, in the expediting their business, yet that they might be more firmly impressed on their minds, he had recourse to a stratagem which it was amply in his power to apply.

During the reigns of Edward VI. and Queen Mary this enterprizing merchant had been employed as their agent in procuring loans on the Continent, and had conducted himself with so much prudence and success, that Queen Elizabeth entrusted him with similar commissions, particularly at Antwerp, where he procured her large sums. This method of proceeding did not, however, accord with the patriotic views of our great trader, who contrived to prevail upon the sovereign to apply to her own subjects for assistance, which he more than once afforded her himself with much profitable advice on financial matters. The stratagem alluded to was the prevailing on the Queen to go in solemn procession to the new Exchange, and there proclaim it such, under the additional sanction of her royal protection and recommendation. Had this monarch been less attached to splendid exhibitions of regal state, the claims of Sir Thomas on her gratitude were sufficiently powerful to demand a still greater favour. It is not, therefore, to be wondered at, that she readily consented to perform her part, particularly as it was intimately connected with the future welfare of her good city of London. Accordingly, after due preparation, her Majesty departed from Somerset House, in the Strand, on the twenty-third of January, 1570, attended by the officers of her court and a train of nobility, to the magnificent residence of Sir Thomas, who, at a very great expense, provided a most superb entertainment for his royal guest, her attendants, and the principal citizens; after which the whole party went to the new edifice, where every possible display of rich goods was made in the shops, the occupiers of which, delighted with the condescension of their Queen, endeavoured to exceed each other in gratifying her curiosity, and expressing their loyalty and gratitude. The moment, at length, arrived for the accomplishment of this well-concerted plan; and Sir Thomas and the citizens had the satisfaction of hearing a herald proclaim the place a Royal Exchange by the sound of trumpet, at the express command of her majesty.

It appeared sufficiently plain after the decease of Sir Thomas Gresham, that he had not erred in his calculations on the probable profits of the Exchange, as it was known that his lady received 751*l.* 5*s.* per annum in rents from it. And this result is precisely what a generous citizen would wish, that public advantage should be attended with private benefit to the successors of a public benefactor. The difficulty attending procuring the perusal of the archives of the different institutions of London, has hitherto prevented the historian from giving a sketch of the existing connection between the estate of Sir Thomas Gresham held by the Company of Mercers and the City of London; but it is certain that, after the year 1596, all the affairs of Sir Thomas Gresham's trust were managed by a committee of four aldermen and eight commoners on the part of the Corporation; and by the master, wardens, and eight of the court of assistants of the Mercers' Company.

The dreadful calamity of 1666 destroyed the old Royal Exchange, when only 234*l.* 8*s.* 2*d.* belonging to the Gresham trust remained in the coffers of the Company; and yet the persons composing it contrived to employ labourers to remove the ruins within six months after the conflagration occurred, in order to prepare the ground for the present structure; and on the twenty-fifth of February the King was petitioned for a supply of Portland stone. In September, 1667, the committee appointed to superintend the rebuilding of the Exchange submitted their plans and elevations to the inspection of Charles II., at the same time requesting permission to project the south portico into Cornhill. They had soon the satisfaction of hearing that the first were highly approved of, and that their request was granted. On the twenty-third of October, in the above year, the monarch went to the scite, and placed the base of the pillar on the west side of the north entrance, after which he accepted of a handsome entertainment provided at the joint expense of the City and Company of Mercers, and served under a temporary building erected on the Scotch walk. In return for this hospitality, the King knighted the Sheriffs Gauden and Davis, and gave 20*l.* in gold to the workmen. James, Duke of York, laid the first stone of the eastern pillar, on the thirty-first of October; and on the eighteenth of the following month Prince Rupert placed that on the east side of the south entrance, each being entertained in a sumptuous manner.

The Committee, inspecting the plan made by Mr. Jerman for rebuilding the Exchange, on the 9th of December, 1667, resolved "that portices should be built on the north and south sides, according as his Majesty desires, and as are described in the aforesaid draft; and that houses shall be built on the heads of the said porticos, and shops underneath. Mr Malcolm has collected many particulars relating to this noble edifice, in his "Londinium Redivivum," and amongst others, the following extract from a book produced to a Committee of the House of Commons, 1747. "The said book begins the 27th of October, 1666, and ends July 12, 1676; and it thereby appears that the total expense of rebuilding the Royal Exchange amounted unto 58,962*l.*; the Company's moiety whereof was the sum of 29,481*l.* To defray which expense, it appeared the Company were obliged to borrow money upon their seal, insomuch that in the year 1682, they had taken up money on their bonds, on account of the trust of Sir Thomas Gresham, to the amount of 45,795*l.*" It appeared, on this occasion, from the evidence of a Mr. Crampe, "that the company had hitherto contributed equally with the city in the repairing of the Royal Exchange, and paying Sir Thomas Gresham's lectures and charities; and that, in or about the year 1729, one of the lecturers of Sir Thomas Gresham filed a bill, in Chancery, against the City of London, and the Mercer's company; to answer which, it became necessary to draw out and state an account between the Mercer's Company, and Sir Thomas Gresham's trust estates, as also between the City and Company and the said estate; and accordingly, such accounts were drawn up: and thereby it appears, that there was due to the Mercer's Company, for their moiety of the expense of building the Royal Exchange, and other payments up to that time, the sum of 100,659*l.* 18*s.* 10*d.*" Mr. Cawne, the then Clerk of the Company of Mercers, produced a continuation of this account to the Committee above-mentioned, down to 1745, when the principal and interest amounted to the enormous sum of 142,885*l.* 7*s.* 1*d.*

In the year 1767, it was represented to the Legislature that essential repairs were required in different parts of the Royal Exchange, which procured a grant of 10,000*l.* and these were completed under the direction of Mr. Robinson, surveyor, who thought proper to rebuild the west side.

During the time occupied in rebuilding the present structure, the merchants of London transacted their business at Gresham College; and the new building was opened for that purpose, September 28, 1669: in 1703, the following notice appeared in the public papers: "An act of the Lord Mayor and Court of Aldermen is affixed at the Exchange, and other places in this City, by which all persons are prohibited coming upon the Royal Exchange to do business before the hours of twelve o'clock, and after the hour of two, till evening change. Wherein it is further enacted, that for a quarter of an hour before twelve the Exchange bell shall ring, as a signal of change time; and shall also begin to ring a quarter of an hour before two, at which time the change shall end: and all persons shall quit it, upon pain of being prosecuted to the utmost according to law. That the gates shall then be shut up, and continue so till evening change time; which shall be

from the hours of six to eight from Lady-day till Michaelmas, and from Michaelmas to Lady-day from the hours of four to six; before and after which hours the bell shall ring as above-said. And it is further enacted, that no persons shall assemble in companies, as stock-jobbers, &c. either in Exchange Alley, or places adjacent, to stop up and hinder the passage from and to the respective houses thereabouts, under pain of being immediately carried before the Lord Mayor, or other Justice of the Peace, and prosecuted."

There are at present numerous shops encircling the Royal Exchange, but they are confined to the ground floor, under the arches or piazza; many years past the upper rooms were used for this purpose, and it has been said to the amount of two hundred. Lloyd's Coffee-House now occupies the greater part of the upper story.

Before the present unhappy war, the Royal Exchange of London presented an epitome of the world, where specimens of all the varieties of man might be seen and studied; in which point of view it was equally valuable to the philosopher as to the merchant for his extended pursuits, nor was it less useful to the observer of the manners of different nations; now, unfortunately, neither the philosopher, the observer of manners, nor the merchant, finds it a place of its original attraction. The frantic decrees against the commerce of England, on the continent, and the necessary reprisals of our own government, are the causes which have rendered the area of the Royal Exchange a splendid desart, compared to what it has been; but the enterprising spirit of our traders, which outstrips all the cold calculations of politicians, may serve to convince the world that though this spirit may be checked for a short time, it can never be extinguished, nor will all the powers of the earth combined produce the growth of grass between the stones of its pavement.

The architectural decorations render the exterior and interior fronts of the Royal Exchange an ornament to the vast metropolis of England. The form is square, and the area the same; there are four gates which face the cardinal points, but the principal is in Cornhill. Mr. Malcolm informs us that the statues of George I. and George II. are by Rysbrack; his present Majesty's by Wilton, which was erected in March, 1764; and that most of the Kings previously to Charles II. were sculptured by Cibber; that of the latter King, which originally stood in the area, is the work of Grinlin Gibbons, the unrivalled carver in wood; those of Charles I. and II., on the principal front, are by Bushnell. The statue of Charles II., in the area, was a few years since replaced by another in a Roman habit, the performance of Mr. Spiller. We shall conclude this slight sketch of the history of the Royal Exchange, with a brief description by the author just-mentioned. The grand gateway is in the centre intercolumniation of four Corinthian pillars, which are the whole height of the front, and have a complete entablature, the great arch reaching to the architrave. In the attic, directly over the gate, are the royal arms, and this forms the base of the steeple, on which there are three gradations, or stories, each bounded by pilasters and pillars, with entablatures and balustrades, and busts in place of vases, the usual ornaments of this sort of magnificent edifices; except the third, which has pediments on each side, with a cupola arising from the centre. On this is a globe and gilt grasshopper.

Over each side intercolumniation of the front are circular pediments, above them are attics and balustrades, with the Mercers crest and the City supporters. The lesser entrances have divided pediments, and over them Corinthian niches, and pediments containing statues of King's Charles the First and Second. The wings of the front are five arches in length, on each side of the gates, three of these form a piazza; the two remaining retire into the main building. The basement in which they are turned is rustic, and the story above them Corinthian, with four pillars, an entablature, and balustrade. The three windows of the projection, and those of the building, are exactly attic in their borders, though placed in Corinthian intercolumniations. The four sides of the quadrangle are magnificent, and richly decorated with the basement arches of the walks, the cornices over them, the niches, statues, pillars, circular windows, entablatures, and balustrade, all in correct proportion and arrangement.

ROYENA, in botany, *African bladder-nut*, so named in honour of Adrian Van Royen, a genus of the Decandria Digynia class and order. Natural order of Bicornes. Guaiacanæ, Jussieu. Essential character: calyx pitcher-shaped; corolla one-petalled, with the border revolute; capsule one-celled, four-valved. There are seven species.

RUBIA, in botany, *madder*, a genus of

the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, bell-shaped; berries two, one-seeded. There are seven species. See MADDER.

RUBRIC, in the canon-law, signifies a title or article in certain ancient law-books; thus called because written, as the titles of the chapters in our ancient Bibles are, in red letters. Rubrics also denote the rules and directions given at the beginning, and in the course of, the liturgy, for the order and manner in which the several parts of the office are to be performed. There are general rubrics and special rubrics, a rubric for the communion, &c. In the Romish missal and breviary are rubrics for matins, for lauds, for translations, beatifications, commemorations, &c.

RUBUS, in botany, the *raspberry*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft: petals five; berry composed of one-seeded acini. There are thirty-two species; among which is the R. idæus, or common garden raspberry, too well known to need a particular description: it is found wild in many parts of Europe, particularly in rocky mountains, moist situations, woods, and hedges. The varieties of the raspberry are, the red-fruited, the white-fruited, and the twice-bearing.

RUBY. See CORUNDUM.

RUBY, in heraldry, denotes the red colour wherewith the arms of noblemen are blazoned; being the same which in the arms of others, not noble, is called gules.

RUDBECKIA, in botany, so named from Olaus Rudbeck, father and son, professors of botany at Upsal, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx with a double row of scales; crown of the seed a four-toothed rim; receptacle chaffy, conical. There are seven species.

RUDDER, in navigation, a piece of timber turning on hinges in the stern of the ship, and which, opposing sometimes one side to the water and sometimes another, turns or directs the vessel this way or that. The rudder of a ship is a piece of timber hung on the stern posts by four or five iron-hooks, called pintles, serving as it were for the bridle of a ship to turn her about at the pleasure of the steersman. The rudder being perpendicular; and without-side the ship, another piece of timber is fitted to it at right angles, which comes into the ship, by which the rudder is managed and directed. This latter properly is called the helm or tiller; and sometimes, though improperly, the rudder itself. The power of the rudder is reducible to that of the lever. As to the angle the rudder should make with the keel, it is shown, that in the working of ships, in order to stay or bear up the soonest possible, the tiller of the rudder ought to make an angle of 55° with the keel. A narrow rudder is best for a ship's sailing, provided she can feel it; that is, be guided and turned by it: for a broad rudder will hold much water when the helm is put over to any side; but if a ship have a fat quarter, so that the water cannot come quick and strong to her rudder, she will require a broad rudder. The aft-most part of the rudder is called the rake of the rudder.

RUDOLPHINE *Tables*, a set of astronomical tables that were published by the celebrated Kepler, and so called from the Emperor Rudolph, or Rudolphus.

RUELLIA, in botany, so named in honour of Joannes Ruellius, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. *Acanthi*, Jussieu. Essential character: calyx five-parted; corolla subcampanulate; stamens approximating by pairs; capsule opening by elastic teeth. There are forty-three species. Swartz observes, that the Ruelliæ are very nearly allied to the Justiciæ in their natural order, flowers, fruit, and habit.

RUIZIA, in botany, so named in honour of Don Hipolito Ruiz, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. *Malvaceæ*, Jussieu. Essential character: calyx double, exterior three-leaved; styles ten; capsule ten, one-celled, two-seeded, closely cohering. There are three species, all natives of the Isle of Bourbon.

RULE, in arithmetic, denotes an operation performed with figures, in order to discover sums or numbers unknown. The fundamental rules are addition, subtraction, multiplication, and division. But, besides these, there are other rules, denominated from their use; as the rule of ALLIGATION, FELLOWSHIP, INTEREST, PRACTICE, REDUCTION, &c. which see in the alphabetical order.

RULE *of Three*, GOLDEN *Rule*, or RULE *of Proportion*, is one of the most essential rules of arithmetic; for the foundation of which see the article PROPORTION. It is

called the Rule of Three from having three numbers given to find a fourth; but more properly, the Rule of Proportion, because by it we find a fourth number proportional to three given numbers: and because of the necessary and extensive use of it, it is called the Golden Rule. But to give a definition of it, with regard to numbers of particular and determinate things, it is the rule by which we find a number of any kind of things, as money, weight, &c. so proportional to a given number of the same things, as another number of the same or different things is to a third number of the last kind of thing. For the four numbers that are proportional must either be all applied to one kind of things; or two of them must be of one kind, and the remaining two of another: because there can be no proportion, and consequently no comparison of quantities of different species; as, for example, of three shillings and four days: or of six men and four yards. All questions that fall under this rule may be distinguished into two kinds: the first contains those wherein it is simply and directly proposed to find a fourth proportional to three given numbers taken in a certain order: as if it were proposed to find a sum of money so proportioned to one hundred pounds as sixty-four pounds ten shillings is to eighteen pounds six shillings and eight-pence, or as forty pounds eight shillings is to six hundred weight. The second kind contains all such questions wherein we are left to discover, from the nature and circumstances of the question, that a fourth proportional is sought; and consequently, how the state of the proportion, or comparison of the term, is to be made; which depends upon a clear understanding of the nature of the question and proportion. After the given terms are duly ordered, what remains to be done is to find a fourth proportional. But to remove all difficulties as much as possible, the whole solution is reduced to the following general rule, which contains what is necessary for solving such questions wherein the state of the proportion is given; in order to which it is necessary to premise these observations.

1. In all questions that fall under the following rule there is a supposition and a demand; two of the given numbers contain a supposition, upon the conditions whereof a demand is made, to which the other given term belongs; and it is therefore said to raise the question; because the number sought has such a connection with it as one of these in the supposition has to the other. For example: if three yards of cloth cost 4*l.* 10*s.* (here is the supposition) what are 7 yards 3 quarters worth? here is the demand or question raised upon 7 yards 3 quarters, and the former supposition.

2. In the question there will sometimes be a superfluous term; that is, a term which, though it makes a circumstance in the question, yet it is not concerned in the proportion, because it is equally so in both the supposition and demand. This superfluous term is always known by being twice mentioned either directly, or by some word that refers to it. Example, if three men spend 20*l.* in 10 days, how much, at that rate, will they spend in 25 days? Here the three men is a superfluous term, the proportion being among the other three given terms, with the number sought; so that any number of men may be as well supposed as 3.

Rule. 1. The superfluous term (if there is one) being cast out, state the other three terms thus: of the two terms in the supposition, one is like the thing sought (that is, of the same kind of thing the same way applied); set that one in the second or middle place; the other term of the supposition set in the first place, or on the left hand of the middle; and the term that raises the question, or with which the answer is connected, set in the third place, or on the right hand; and thus the extremes are like one another, and the middle term like the thing sought: also the first and second terms contain the supposition, and the third raises the question; so that the third and fourth have the same dependance or connection as the first and second. 2. Make all the three terms simple numbers of the lowest denominations expressed, so that the extremes be of one name. Then, 3. Repeat the questions from the numbers thus stated and reduced (arguing from the supposition to the demand), and observe whether the number sought ought to be greater or lesser than the middle term, which the nature of the question, rightly conceived, will determine; and, accordingly, multiply the middle term by the greater or lesser extreme, and divide the product by the other, the quote is like the middle term, and is the complete answer, if there is no remainder; but if there is, then, 4. Reduce the remainder to the denomination next below that of the middle term, and divide by the same divisor, the quotient is another part of the answer in this new denomination. And if there is here also a remainder, re-

duce it to the next denomination, and then divide. Go on thus to the lowest denomination, where, if there is a remainder, it must be applied fraction-wise to the divisor; and thus you will have the complete answer in a simple or mixed number.

Note. If any of the dividends is less than the divisor, reduce it to the next denomination, and to the next again, till it be greater than, or equal to, the divisor.

EXAMPLES.

Quest. 1. If 3 yards of cloth cost 8*s.* what is the price of 15 yards? Answ. 40*s.* or 2*l.*

Work.

```
yds.  s.  yds.
 3 — 8 — 15
     15
 3)120(40s.
```

Explanation. 3 yards and 8*s.* contain the supposition, and 8*s.* is like the thing sought; therefore 8*s.* is the middle term, and yards on the left: then the demand arises upon 15 yards, and therefore it is on the right. Again, from the nature of the question it is plain, that 15 yards require more than 3 yards, i. *e.* the answer must be greater than the middle term; wherefore 8*s.* is to be multiplied by 15 yards; the product is 120*s.* which divided by 3 yards, quotes 40*s.* without a remainder; so 40*s.* or 2*l.* is the number sought.

Quest. 2. If 4*lb.* of sugar cost 2*s.* 9*d.* what is the value of 18*lb.*? Answer, 12*s.* 4½*d.*

Work.

```
lb.  s.  d.   lb.
4 — 2 : 9 — 18
    12
    33 d.
    18
   264
   33
4)594(148 d.
     2
     4
  4)8(2 farthings.
```

Explanation. The supposition is in 4 *lb.* and 2*s.* 9*d.* this last term being like the thing sought, which is connected with 18 *lb.* wherefore the terms are stated according to the rule: then the middle term being mixed, it is to be reduced to pence; and then argue thus; if 4 *lb.* cost 33*d.*, 18*lb.* must cost more; therefore multiply 33*d.* by 18*lb.* and divide their product by 4; the quotient is 148*d.* and 2 remains, which is to be reduced to farthings, and the product divided by the former quotient, gives 2; so the answer is 148*d.* 2 farthings, or 12*s.* 4½*d.* because 148*d.* is by reduction, 12*s.* 4*d.*

Quest. 3. What time will 7 men be boarded for 25*l.* when 3 men paid 25*l.* for 6 months? Answ. 2 months, 16 days, reckoning 28 days to 1 month.

Work.

```
men. mnths. men.
 3 —— 6 —— 7
      3
   7)18(2
     14
 Rem. 4
     28
   7)112(16 days.
```

Explanation. The 25*l.* is a superfluous number; then the supposition is in the 3 men and 6 months, and the demand regards the 7 men: the terms being all simple, you are to argue thus; if 3 men are boarded 6 months for 25*l.* (or any sum), 7 men will be boarded for the same a shorter time: therefore multiply 6 months by 3, and divide the product 18 by 7, whereby the answer is found to be 2 months and 16 days.

Note. The first two questions are what is called the rule of three direct, that is, where the third term, being greater or less than the first, requires that the answer also be greater or lesser than the second term. The last, of the rule of three indirect, or reverse; where the third term being greater or lesser than the first, requires the fourth contrarily lesser or greater than the second. But we have comprehended both in one general rule. And from this observation may be learned what questions are of either kind.

RULE, or RULER, an instrument of wood or metal, with several lines delineated on it, of great use in practical mensuration. When a ruler has the lines of chords, tangents, sines, &c. it is called a plane scale.

The carpenter's joint-rule is an instrument usually of box, &c. twenty-four inches long, and one and a half broad; each inch being subdivided into eight parts. On the same side with these divisions is usually added Gunter's line of numbers. On the other side are the lines of timber and board measure; the first beginning at 8½, and continued to 36, near the other end; the

latter is numbered from 7 to 36, 4 inches from the other end. We shall point out some of the uses of this rule.

The application of the inches, in measuring lengths, breadths, &c. is obvious. That of the Gunter's line, see under the article GUNTER'S LINE.

The use of the other side is that with which we are now concerned. 1. The breadth of any surface, as board, glass, &c. being given, to find how much in length makes a square foot. Find the number of inches the surface is broad, in the line of board measure, and right against it is the number of inches required. Thus, if the surface were eight inches broad, eighteen inches will be found to make a superficial foot. Or more readily thus: apply the rule to the breadth of the board, or glass, that end, marked 36, being equal with the edge, the other edge of the surface will show the inches, and quarters of inches, which go to a square foot. 2. Use of the table at the end of the board-measure. If a surface be one inch broad, how many inches long will make a superficial foot? look in the upper row of figures for one inch, and under it in the second row is twelve inches, the answer to the question. 3. Use of the line of timber-measure. This resembles the former; for having learned how much the piece is square, look for that number on the line of the timber-measure; the space thence to the end of the rule is the length which, at that breadth, makes a foot of timber. Thus, if the piece be nine inches square, the length necessary to make a solid foot of timber is 21¼ inches. If the timber be small, and under nine inches square, seek the square in the upper rank of the table, and immediately under it is the feet and inches that make a solid foot. If the piece be not exactly square, but broader at one end than the other, the method is to add the two together, and take half the sum for the side of the square. For round timber the method is to girt it round with a string, and to allow the fourth part for the side of the square; but this method is erroneous, for hereby you lose nearly one fifth of the true solidity; though this is the method at present practised in buying and selling timber.

RULE, *Coggeshall's sliding*, is chiefly used for measuring the superficies and solidity of timber, &c. It consists of two rulers, each a foot long, one of which slides in a groove made along the middle of the other.

On the sliding side of the rule are four lines of numbers, three whereof are double; that is, are lines to two radiuses; and one, a single broken line of numbers: the three first, marked A, B, C, are figured 1, 2, 3, &c. to 9; then 1, 2, 3, &c. to 10. The single line, called the girt-line, and marked D, whose radius is equal to the two radiuses of any of the other lines, is broke for the easier measurement of timber, and figured 4, 5, 6, 7, 8, 9, 10, 20, 30, &c. From 4 to 5 it is divided into ten parts, and each tenth subdivided into 2, and so on, from 5 to 6, &c. On the backside of the rule are, 1. A line of inch-measure, from 1 to 12; each inch being divided and subdivided. 2. A line of foot measure, consisting of one foot, divided into 100 equal parts, and figured 10, 20, 30, &c. The back part of the sliding piece is divided into inches, halves, &c. and figured from 12 to 24; so that when drawn wholly out, there may be a measure of two feet.

"Use of Coggeshal's Rule for measuring plane superficies." 1. To measure a square: suppose, for instance, each of the sides 5 feet; set 1 on the line B, to 5 on the line A; then against 5 on the line B is 25 feet, the content of the square on the line A. 2. To measure a long square. Suppose the longest side 18 feet, and the shortest 10; set 1 on the line B, to 10 on the line A; then against 18 feet, on the line B, is 180 feet, the contents on the line A. 3. To measure a rhombus. Suppose the side 12 feet, and the length of a perpendicular let fall from one of the obtuse angles to the opposite side, 9 feet; set 1 on the line B, 12, the length of the side on the line A: then against 9, the length of the perpendicular on the line B, is 108 feet, the content. 4. To measure a triangle. Suppose the base 7 feet, and the length of the perpendicular let fall from the opposite angle to the base 4 feet; set 1 on the line B, to 7 on the line A; then against half the perpendicular, which is 2 on the line B, is 14 on the line A, for the content of the triangle. 5. To find the content of a circle, its diameter being given. Suppose the diameter 3.5 feet; set 11 on the girt line D, to 95 on the line C; then against 3.5 feet on D, is 9.6 on C, which is the content of the circle in feet. 6. To find the content of an oval or ellipsis. Suppose the longest diameter 9 feet, and the shortest 4. Find a mean proportional between the two, by setting the greater 9 on the girt line, to 9 on the line C; then against the less number 4

on the line is C 6, the mean proportional sought. This done, find the content of a circle, whose diameter is 6 feet; this, when found, by the last article, will be equal to the content of the ellipsis sought.

"Use of Coggeshal's Rule in measuring timber." 1°. To measure timber the usual way. Take the length in feet, half feet, and, if required, quarters; then measure half way back again; then girt the tree with a small cord or line; double this line twice very evenly, and measure this fourth part of the girt or perimeter in inches, halves, and quarters. The dimensions thus taken, the timber is to be measured as if square, and the fourth of the girt taken for the side of the square, thus; set 12 on the girt line D, to the length in feet on the line C; then against the side of the square, on the girt-line D, taken in inches, you have, on the line C, the content of the tree in feet. For an instance: suppose the girt of a tree, in the middle, be 60 inches, and the length 30 feet, to find the content, set 12 on the girt-line D, and 30 feet on the line C; then against 15, one fourth of 60, on the girt-line D, is 46.8 feet, the content on the line C. If the length should be 9 inches, and the quarter of the girt 35 inches; here, as the length is beneath a foot, measure it on the line of foot-measure, and see what decimal part of a foot it makes, which you will find .75. Set 12, therefore, on the girt line, to 75 on the first radius of the line C, and against 35 on the girt-line is 64 feet on C, for the content. 2°. To measure round timber the true way. The former method, though that generally in usé is not quite just. To measure timber accurately, instead of the point 12 on the girt-line, use another, *viz.* 10.635; at which there should be placed a centre-pin. This 10,635 is the side of a square equal to a circle, whose diameter is 12 inches. For an instance: suppose the length 15 feet, and ¼ of the girt 42 inches, set the point 10.635 to 15, the length; then against 42 on the girt-line is 233 feet for the content sought; whereas by the common way, there arises only 184 feet. In effect, the common measure is only to the true measure, as 11 to 14. 3°. To measure a cube. Suppose the sides to be 6 feet each; set 12 on the girt-line D, to 6 on C; then against 72 inches (the inches 6 feet) on the girt-line, is 216 feet on C, which is the content required. 4°. To measure unequally-squared timber; that is, where the breadth and depth are not equal. Measure the length of the piece, and the depth (at the end) in inches: then find a mean proportional between the breadth and depth of the piece. This mean proportional is the side of a square, equal to the end of the piece; which found, the piece may be measured as square timber. For an instance: let the length of the piece of timber be 13 feet, the breadth 23 inches, and the depth 13 inches; set 23 on the girt-line D, to 23 on C; then against 13 on C is 17.35 on the girt-line D, for the mean proportional. Again, setting 12 on the girt-line D, to 13 feet, the length of the line C; against 17.35 on the girt-line is 27 feet, the content. 5°. To measure taper timber. The length being measured in feet, note one-third of it; which is found thus: set 3 on the line A, to the length on the line B; then against 1 on A is the third part on B: then, if the solid be round, measure the diameter at each end in inches, and subtract the less diameter from the greater; add half the difference to the less diameter; the sum is the diameter in the middle of the piece. Then set 13.54 on the girt to the length of the line C, and against the diameter in the middle on the girt-line is a fourth number on the line C. Again, set 13.54 on the girt-line to the third part of the length on the line C; then against half the difference on the girt-line is another fourth number on the line C; these two fourth numbers, added together, give the content. For an instance: let the length be 27 feet (one third whereof is 9) the greater diameter 22 inches, and the lesser 18; the sum of the two will be 40, their difference 4, and half the difference 2, which, added to the less diameter, gives 20 inches for the diameter in the middle of the piece. Now set 13.54 on the girt-line to 27 on the line C, and against 20 on D is 58.9 feet. Again, set 13.44 of the girt-line to 9 on the line C; and against 2 on the girt-line (represented by 20) is .196 parts; therefore, by adding 58.9 feet to .196 feet, the sum is 59.096 feet, the content.

If the timber be square, and have the same dimensions; that is, the length 27 feet, the side of the greater end 22 inches, and that of the lesser 18 inches; to find the content, set 12 on the girt-line to 27, the length on the line C, and against 20 inches, the side of the mean square on the girt-line is 75.4 feet. Again, set 12 on the girt-line to 9 feet, one third of the length, on the line C, and against 2 inches, half the difference of the sides of the squares of the ends on the girt-line, is .25 parts of a foot;

both together make 75.65 feet, the content of the solid.

The girt or circumference of a tree, or round piece of timber given; to find the side of the square within, or the number of inches of a side, when the round timber is squared. Set 10 on A to 9 on B, then against the girt on A are the inches for the side of a square on the line B.

RUM, a species of vinous spirit, distilled from sugar canes.

RUMEN, in comparative anatomy, the paunch, or first stomach of such animals as chew the cud, thence called ruminant animals. The rumen is by far the largest of all the stomachs, and in it the whole mass of crude aliments, both solid and liquid, lies and macerates, to be thence transmitted to the mouth to be again chewed, comminuted, and fitted for further digestion in the other ventricles.

The ruminant animals, Mr. Ray observes, are all hairy quadrupeds, viviparous, and have four stomachs; they also want the dentes primores, or broad teeth in the forepart of the upper jaw, and are furnished with that kind of fat called suet, sebum.

RUMEX, in botany, *dock*, a genus of the Hexandria Trigynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx three-leaved; petals three, converging; seed one, three-sided. There are thirty-six species.

RUMMAGE, in the sea-language, signifies to clear a ship's hold, or to remove goods from one place of it to another.

RUMOURS, spreading such as are false, is criminal and punishable by common law.

RUMPHIA, in botany, so named in honour of George Everhard Rumphius, M. D. a genus of the Triandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx three-cleft; petals three; drupe three-celled. There is only one species, *viz.* R. amboinensis, a native of the East Indies.

RUNDLET, or RUNLET, a small vessel, containing an uncertain quantity of any liquor; from three to twenty gallons.

RUNGS, in a ship, the same with the floor or ground timbers, being the timbers which constitute her floor, and are bolted to the keel, whose ends are rung-heads.

RUNG *heads*, in a ship, are made a little bending, to direct the sweep or mould of the futtocks and navel timbers; for here the lines, which make the compass and bearing of a ship, do begin.

RUNIC, a term applied to the language and letters of the ancient Goths, Danes, and other northern nations.

RUNNER, in the sea language, a rope belonging to the garnet, and to the two bolt-tackles. It is reeved in a single block, joined to the end of a pennant, and has at one end a hook to hitch into any thing, and at the other end a double block, into which is reeved the fall of the tackle, or the garnet, by which means it purchases more than the tackle would without it.

RUNNET, or RENNET, the acid juice found in the stomachs of calves that have fed on nothing but milk, and are killed before the digestion is perfect.

RUPALA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Contortæ. Proteæ, Jussieu. Essential character: calyx none; petals four, cohering at the base; stamina inserted into the middle of the petals; pericarpium one-celled, one-seeded. There are two species, *viz.* R. montana and R. sessilifolia, both natives of Cayenne.

RUPERT'S *drops*, a sort of glass-drops with long and slender tails, which burst to pieces on the breaking off those tails in any part, said to have been invented by Prince Rupert, and therefore called after his name. This surprising phenomenon is supposed to rise from hence, that while the glass is in fusion, or in a melted state, the particles of it are in a state of repulsion; but being dropped into cold water, it so condenses the particles in the external parts of their superficies, that they are easily reduced within the power of each other's attraction, and by that means they form a sort of hard case, which keeps confined the before-mentioned particles in their repulsive state; but when this outer-case is broken, by breaking off the tail of the drop, the said confined particles have then a liberty to exert their force, which they do by bursting the body of the drop, and reducing it to a very peculiar form of powder.

RUPPIA, in botany, so named in memory of Henry Bernhard Ruppius, a genus of the Tetrandria Tetragynia class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: calyx none; corolla none; seeds four, pedicelled. There is but one species, *viz.* R. maritima, sea ruppia, or tassel pond-weed.

RUSCUS, in botany, *butchers broom*, a genus of the Dioecia Syngenesia class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character:

calyx six-leaved; corolla none; nectary central, ovate, perforated at the top. There are five species.

RUSSELIA, in botany, so named in honour of Alexander Russel, M. D. a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-leaved, setaceous at the end; corolla tube very long, hairy at the throat; border two-lipped, lower lip trifid; capsule acuminate, one-celled, two-valved, many-seeded. There is only one species, viz. R. sarmentosa, found by Jacquin about Havana, in close woods and coppices.

RUST *of a metal*, a word that has now given way to the modern term OXIDE, which see.

RUTA, in botany, *rue*, a genus of the Decandria Monogynia class and order. Natural order of Multisilique. Rutaceæ, Jussieu. Essential character: calyx five-parted; petals concave; receptacle surrounded by ten honey dots; capsule lobed. There are seven species.

RUTILE, in mineralogy, a species of the Menachine genus, of a dark blood red colour, of various degrees of intensity passing to a brownish red. It occurs crystallized, and the crystals are longitudinally streaked; externally it is shining and glistening; internally its principal fracture is splendent. It is slightly translucent, brittle; it yields a pale yellow or orange yellow coloured streak. It is easily frangible; specific gravity about 4.2. Without addition it is infusible before the blow-pipe; with borax or alkali it affords a hyacinth transparent glass. It is found to be a pure oxide of menachine, with a slight portion of silica.

RUTULITE, a mineral found in Norway, of a yellowish colour; it occurs massive, disseminated, and crystallized. The crystals are small, singly imbedded, and seldom aggregated. It is translucent on the edges, or opaque, yields a grey streak; it is hard, brittle, and easily frangible. Specific gravity 3.5. It experiences little change before the blow-pipe, without addition, but with borax it forms a yellowish green transparent bead; the constituent parts are different according to the place from which the specimens are found; one from Norway was found to consist of

Silica	22
Oxide of menachine	58
Calcareous earth	20
	100

It is found at Passau, in the district of the Inn, and in several Norwegian mines.

RUYSCHIA, in *botany*, so named in memory of Frederick Ruysch, professor of botany at Amsterdam, a *genus of the* Pentandria Monogynia class and order. Essential character: *calyx* five-leaved; corolla five-petalled, reflexed; *style* none; berry many-seeded. There are two species, viz. R. clusiæfolia, and R. surubea.

RYANIA, in botany, so named in honour of John Ryan, M. D. a genus of the Polyandria Monogynia class *and order. Essential* character: calyx five-leaved, permanent, coloured; corolla none; stigmas four; berry suberous, *one-celled*, many-seeded. There is only one species, viz. R. speciosa, a native of the Isle of Trinidad.

RYE. See SECALE.

RYNCHOPS, the *skimmer*, in natural history, a genus of *birds of the order* Grallæ. Generic character: the bill greatly compressed; lower mandible considerably longer than the upper; nostrils linear and pervious; back toe very small; tail very forked. R. nigra, or the black skimmer, the only species, is twenty inches long and three feet and a half in width. It inhabits America and the East Indies, *and is almost incessantly* on the wing, skimming over the surface of the water, into which it plunges its bill with extreme frequency, *to seize* small fishes, which constitute its chief food. The structure of its bill enables *it to open* oysters and other shell fish with extreme ease, and in stormy weather it is seen on the shores opening and devouring them. *See* Aves, Plate XIII. fig. 3.

END OF VOL. V.

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AVES.

Plate 10

Fig. 1 Motacilla maderaspatensis · Pied Wagtail. – Fig. 2. Muscicapa atricapilla · Pied Fly catcher. – Fig. 3 Motacilla regulus. Golden crested Wren Fig. 4. M. luscinia Nightingale. Fig. 5. Numidia pintado · Guinea hen Fig. 6. Oriolus hæmorrhous · Red rumped Oriole Fig. 7 Parus major · Greater Titmouse Fig. 8 P. cæruleus · Blue Titmouse

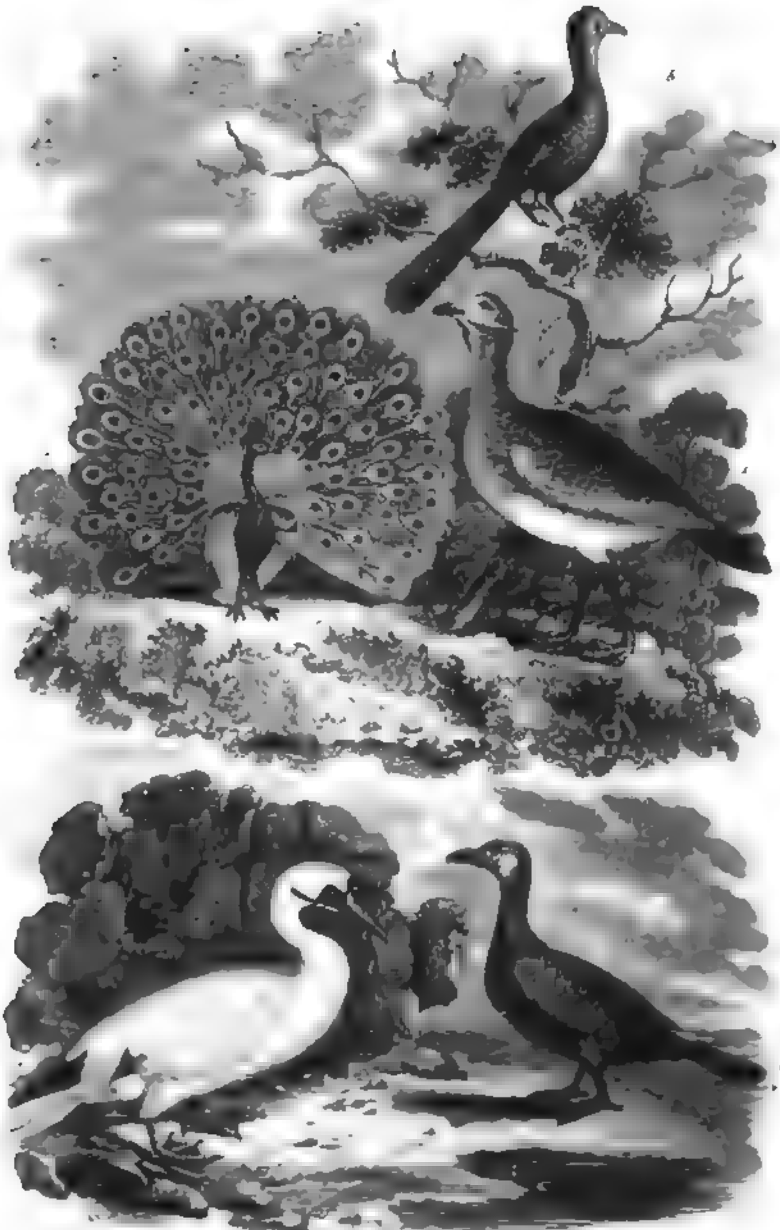

Fig. 1. Otis Tarda: Great Bustard. Fig. 2. Pavo Cristatus. Crested Peacock. Fig. 3 Pelecanus Carbo Cormorant. Fig. 4 P. Bassanus Gannet. Fig. 5. Penelope Marail

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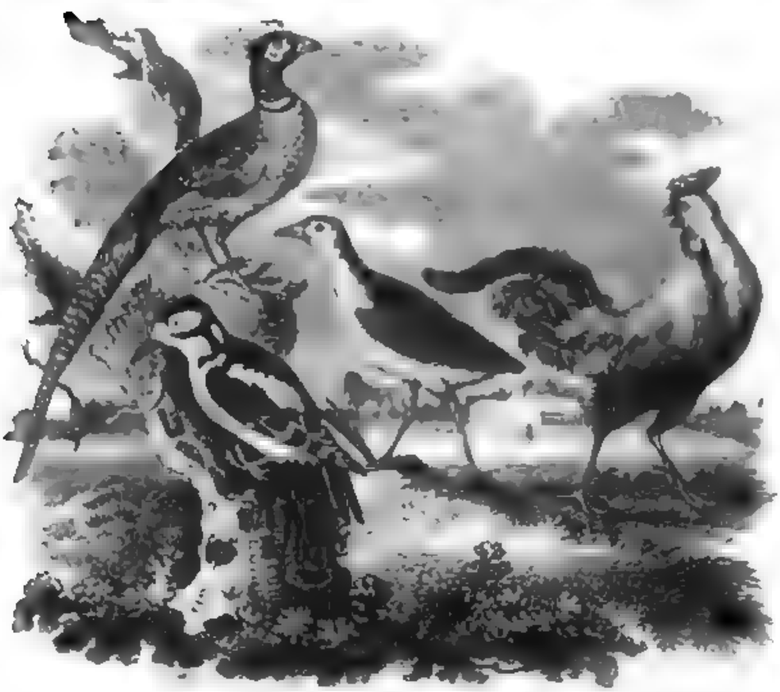

Fig.1 Phasianus Gallus: Domestic Cock. Fig.2 P. Colchicus: Common Pheasant. Fig.3 Picus Major: Greater spotted Wood pecker. Fig.4 Platalea Leucorodia: White Spoon bill. Fig.5 Procellaria Puffinus Shearwater. Fig.6 P. Pelagica: Stormy Petrel. Fig.7 Rallus Crex: Corn Crake.

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ENTOMOLOGY

Plate III

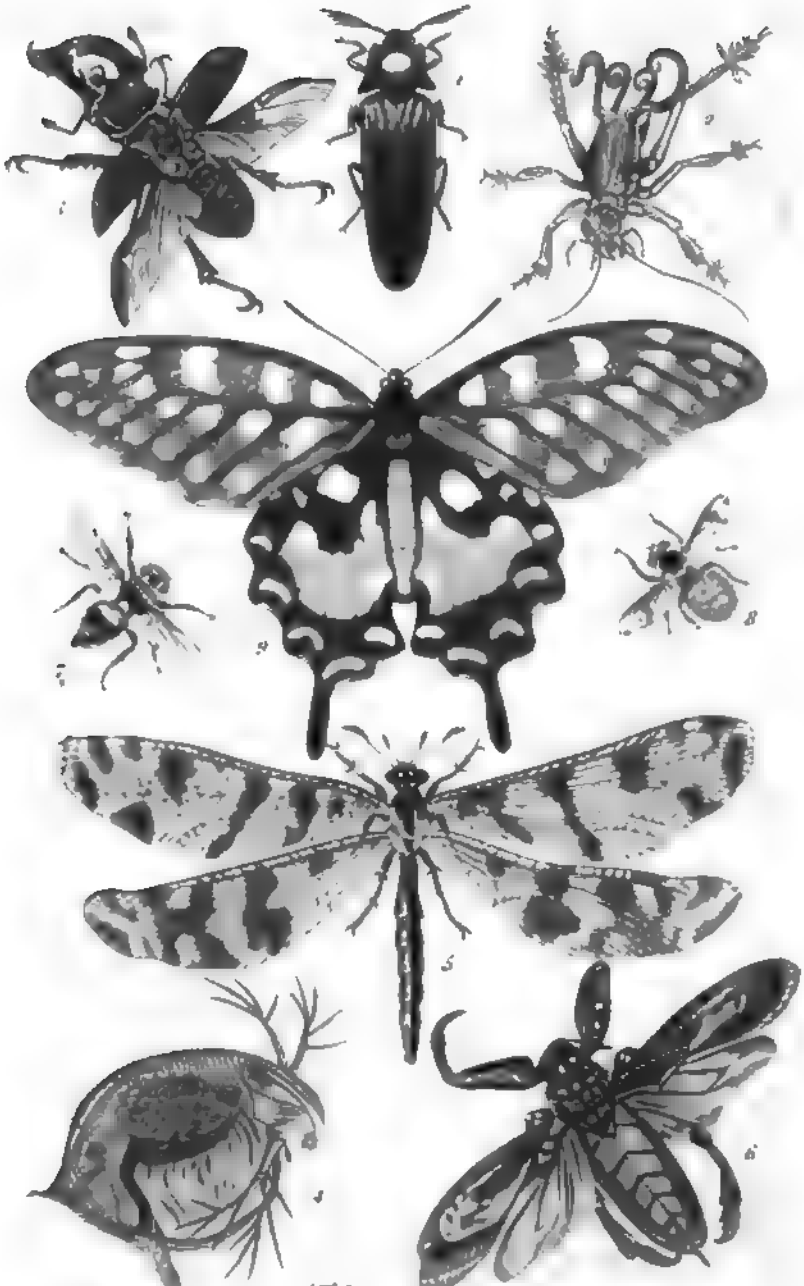

Fig. 1. Elater *flabicornis*. *Fig. 2.* Gryllus *monstrosus*. *Fig. 3.* Lucanus *cervus*. *Fig. 4.* Monoculus *pulex*. *Fig. 5.* Myrmeleon *grande*. *Fig. 6.* Nepa *grandis*. *Fig. 7.* Oestrus *bovis*. *Fig. 8.* O. *equi*. *Fig. 9.* Papilio *antenor*.

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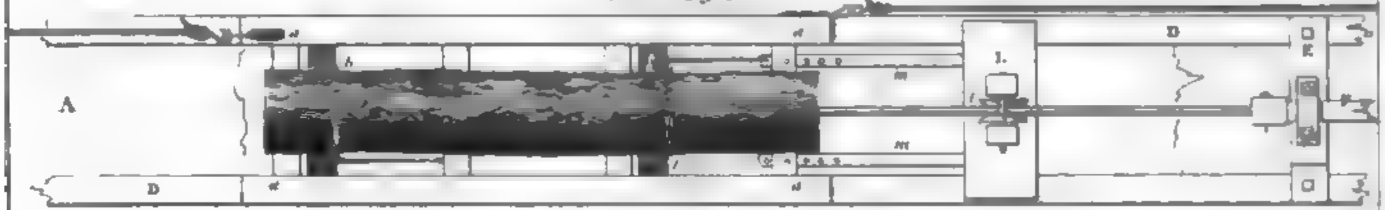
Plan Fig 1



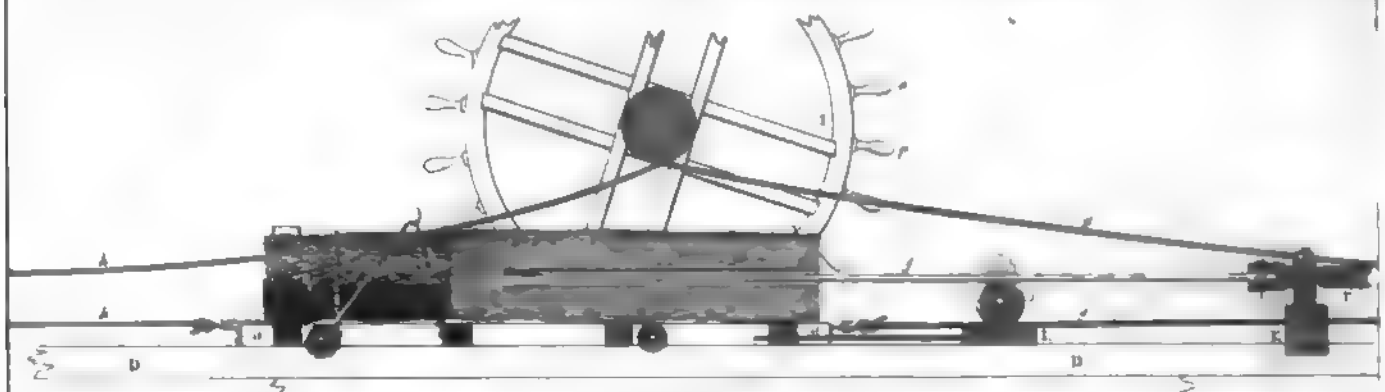


Fig 2 Elevation through the line A B

J Farey Junr delin

Lowry sculp

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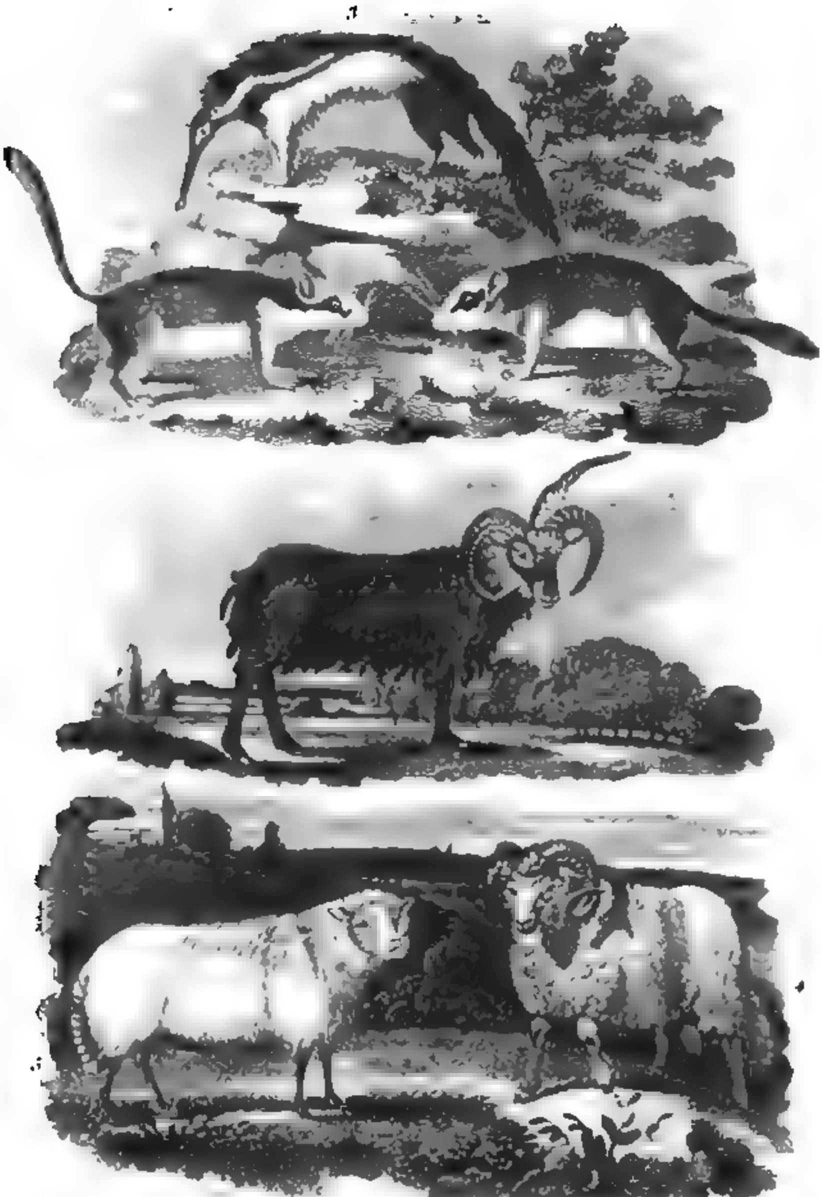

Fig. 1. Myoxus nitela Garden dormouse. Fig. 2. Myoxus dryas Wood dormouse. Fig. 3. Myrmecophaga jubata Great ant-eater. Fig. 4. Ovis aries common ram. Fig. 5. Dunn's sheep. Fig. 6. Many horned Sheep.

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MAMMALIA.

Plate XVIII

Fig. 1. Sciurus vulgaris Common squirrel. Fig. 2. S. getulus Barbary squirrel. Fig. 3. S. niger Black squirrel. Fig. 4. S. volucella Flying squirrel. Fig. 5. Rhinoceros unicornis One horned Rhinoceros.

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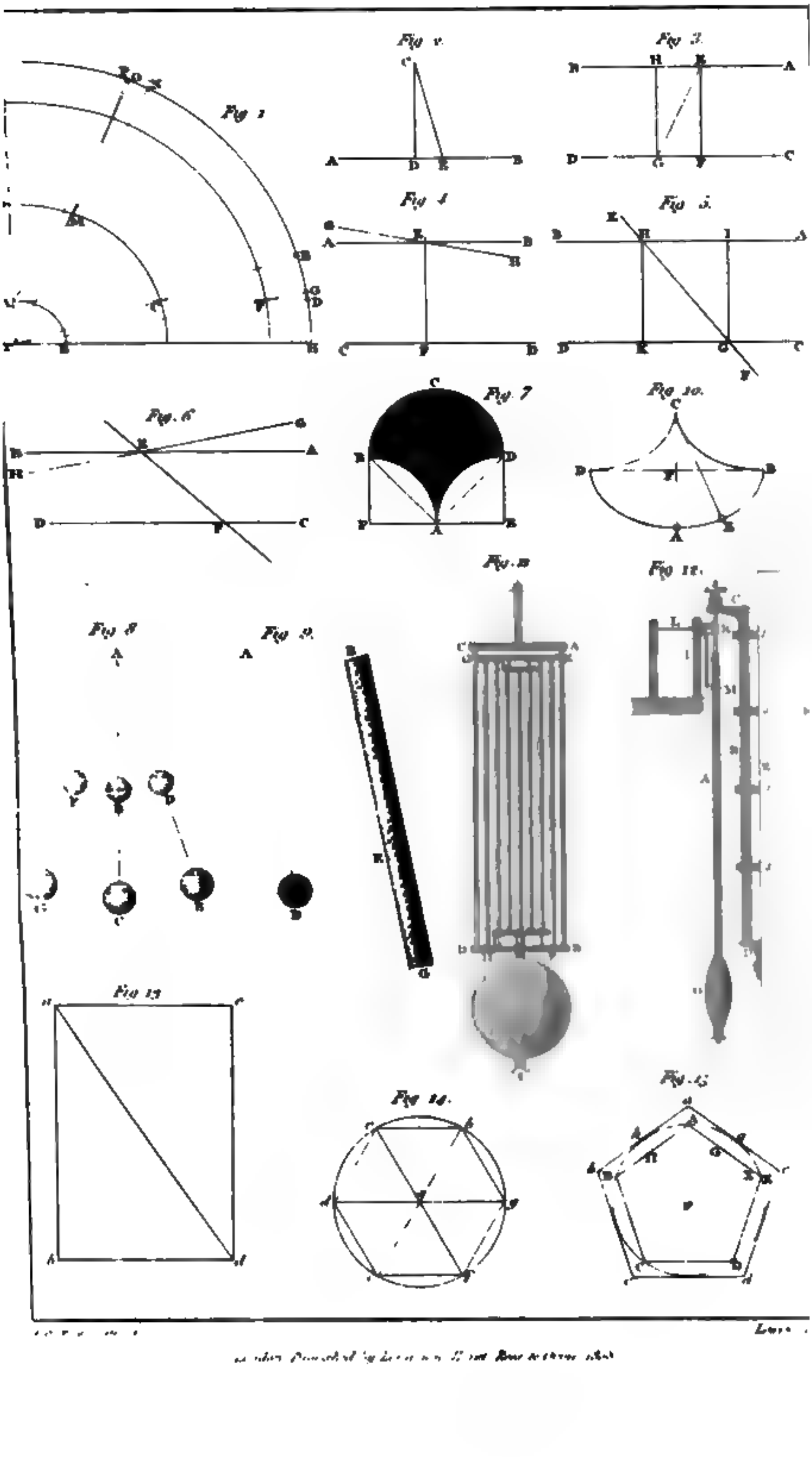
Fig 1
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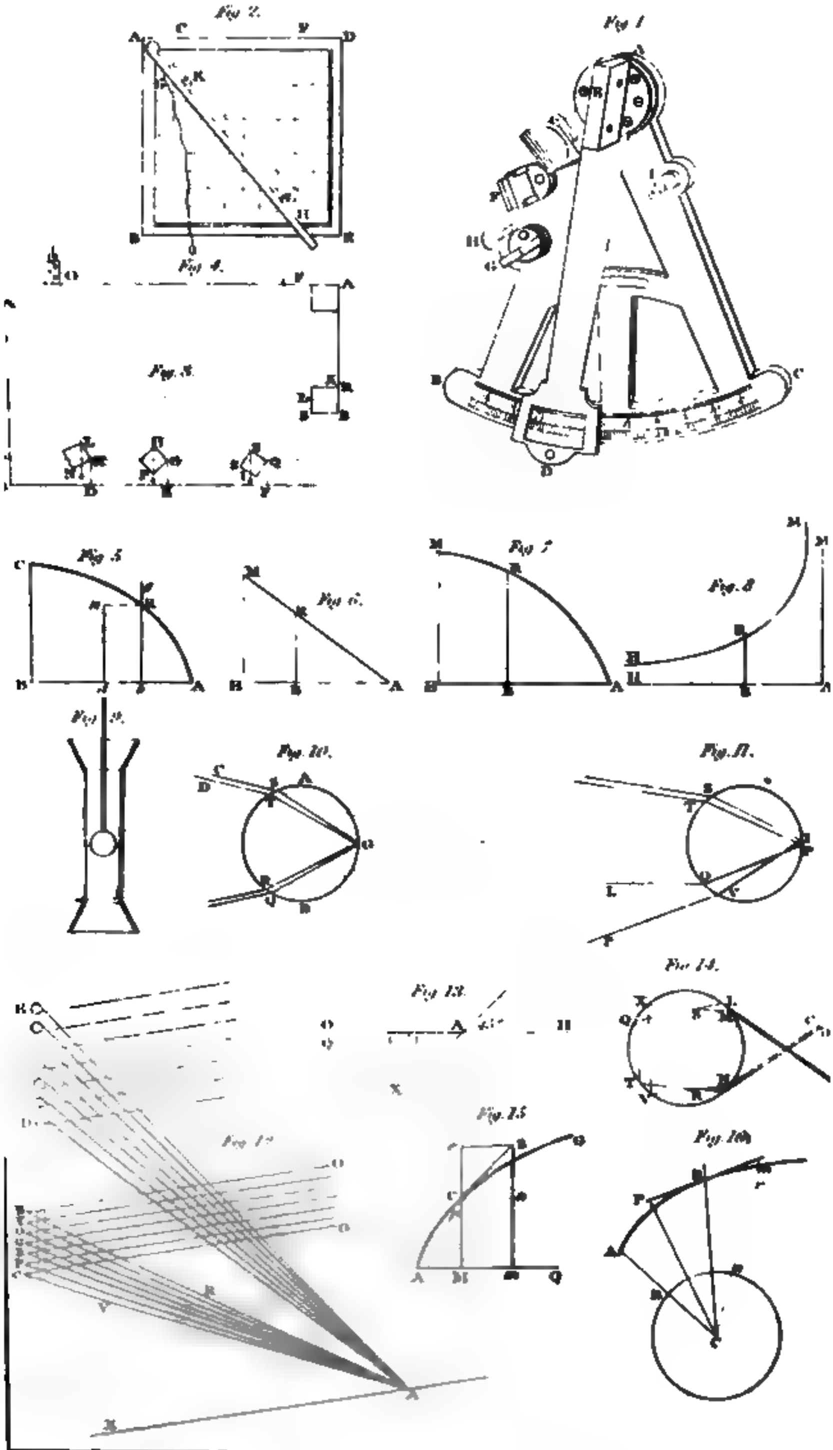
Fig 14
Fig 15



J. Farey Jun.r delin. Lowry sculp.

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OBSERVATORY.

Mr. GRAHAM'S, Equatorial Sector.

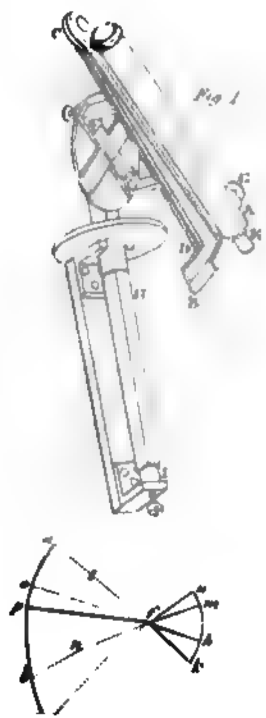


Fig. 1

Transit Instrument.

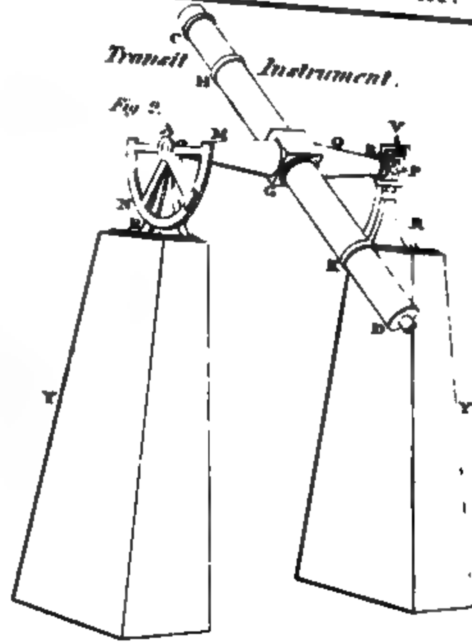
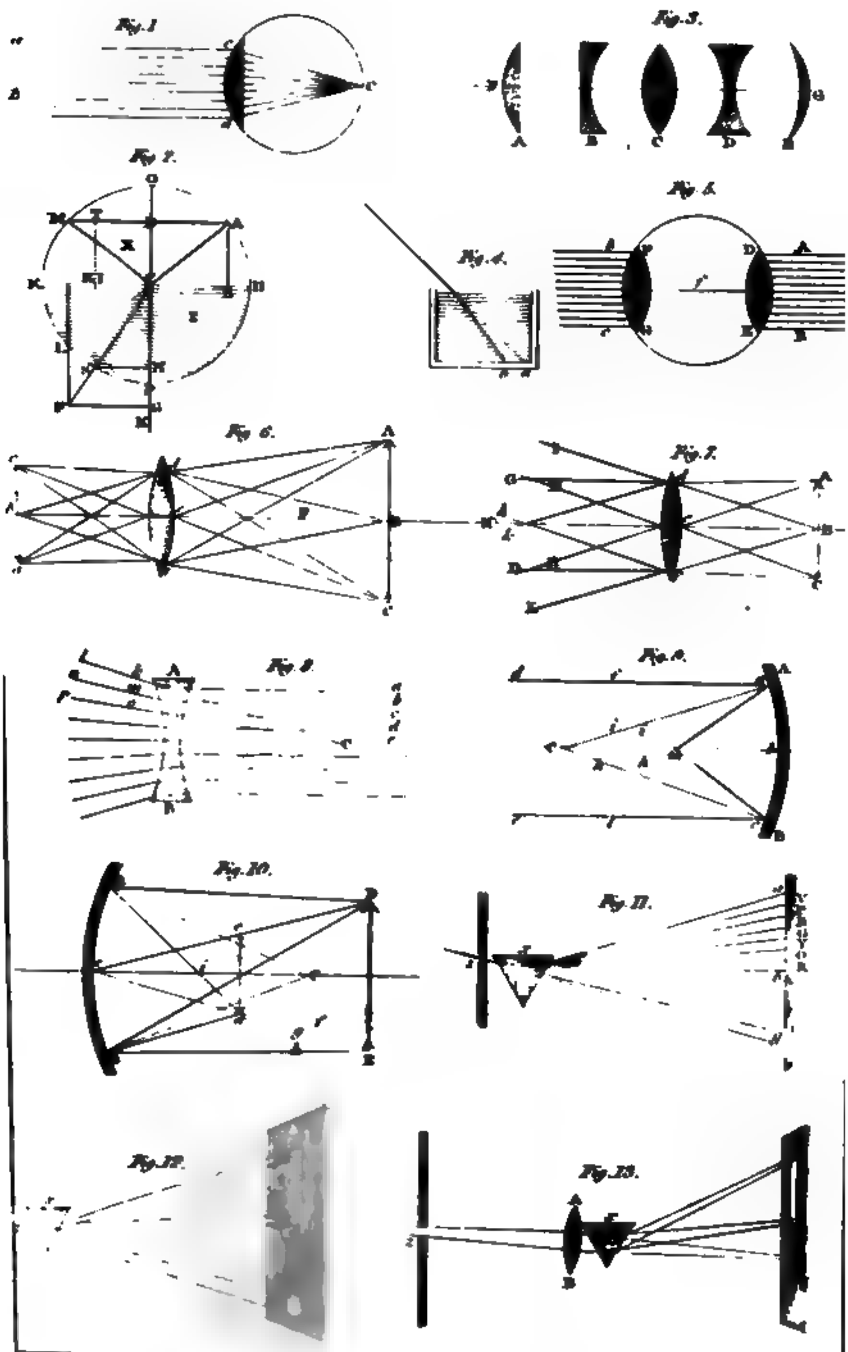


Fig. 2

Mr. RAMSDEN'S, Universal Equatorial.

Fig. 3.

Fig. 4.



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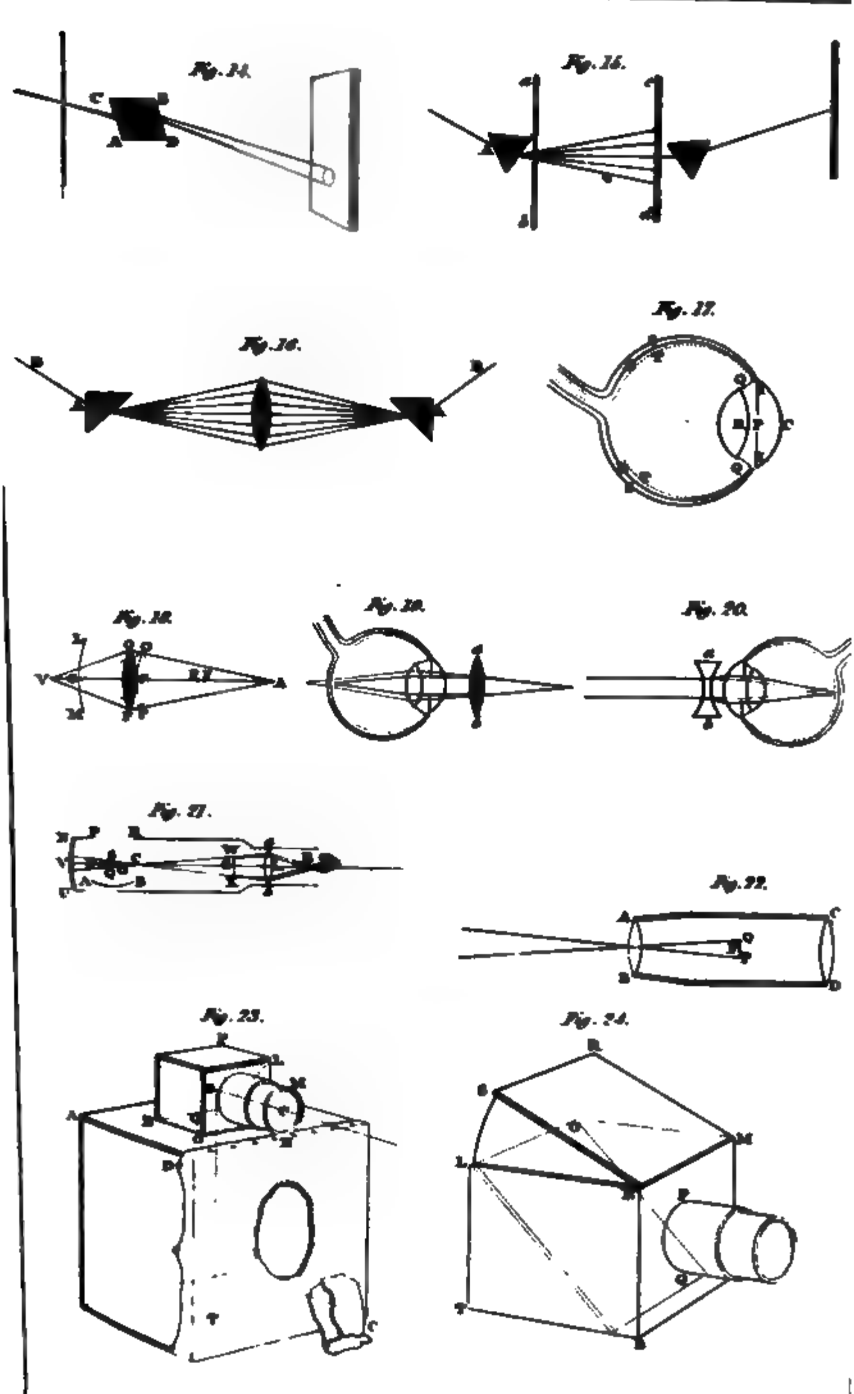

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BARREL ORGAN MADE BY LINCOLN.

Plate I

Fig. 1

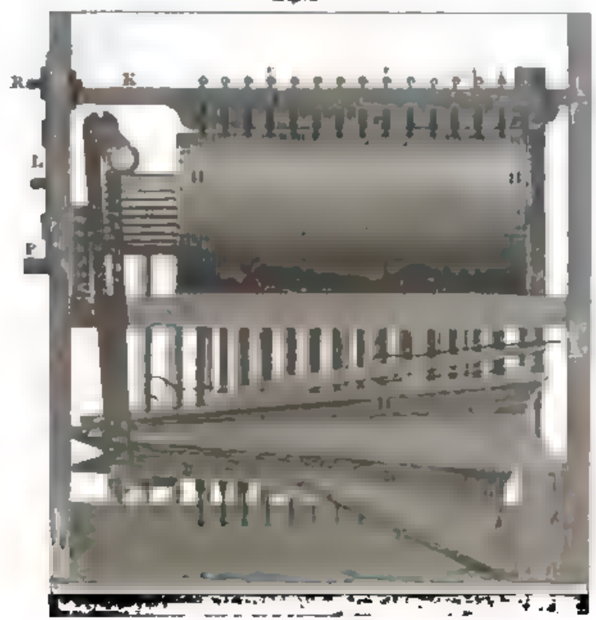


Fig. 2.

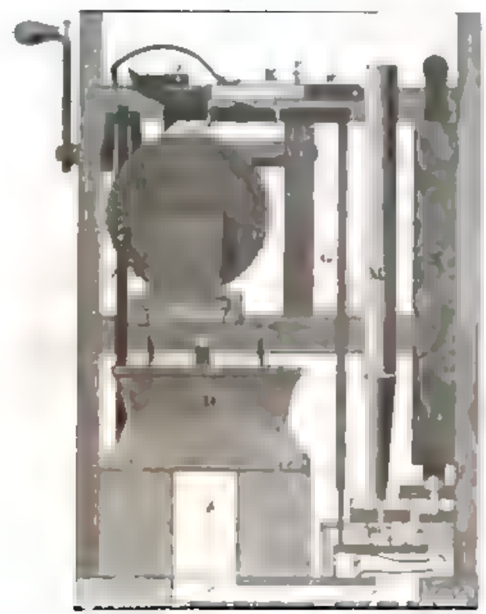


Fig. 3.

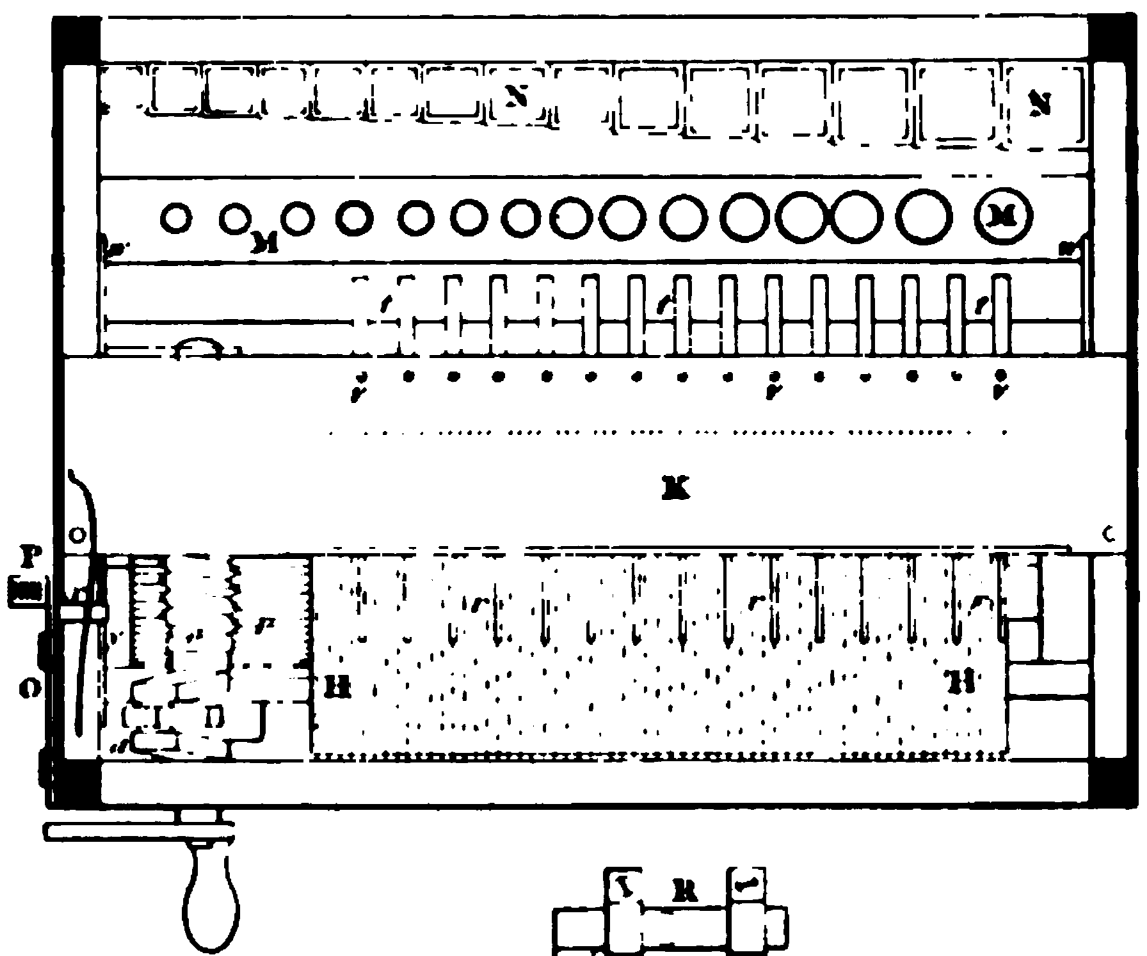


Fig. 7.

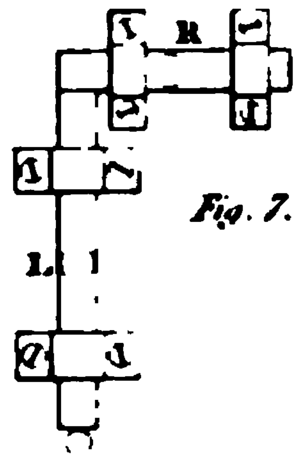


Fig. 4.

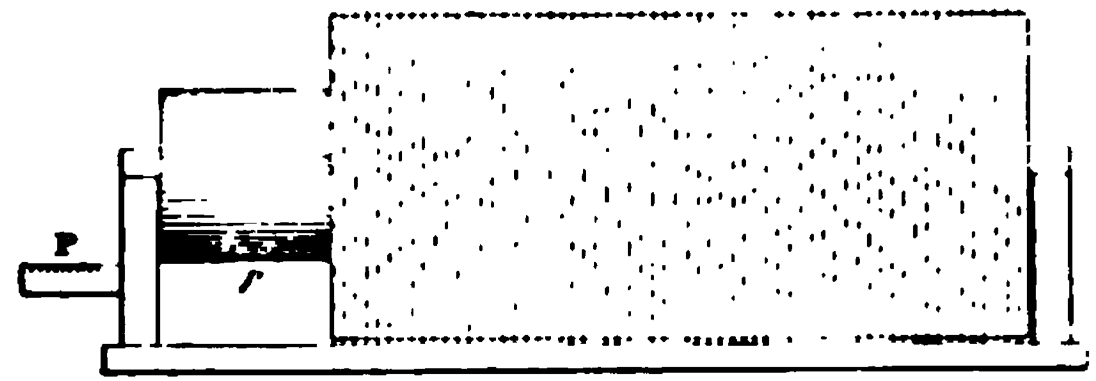


Fig. 5.

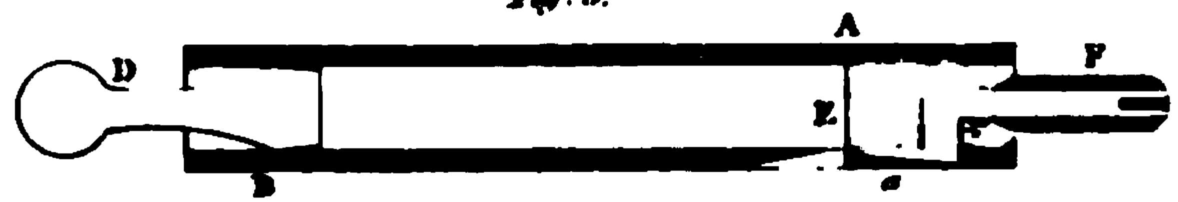
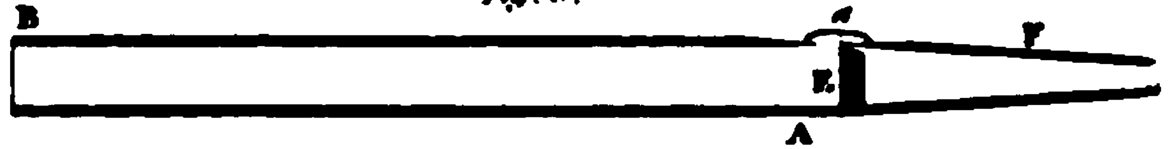


Fig. 6.



J. Farey Jun.r delin

Lowry sculp.

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ORYCTOLOGY. *Plate I*

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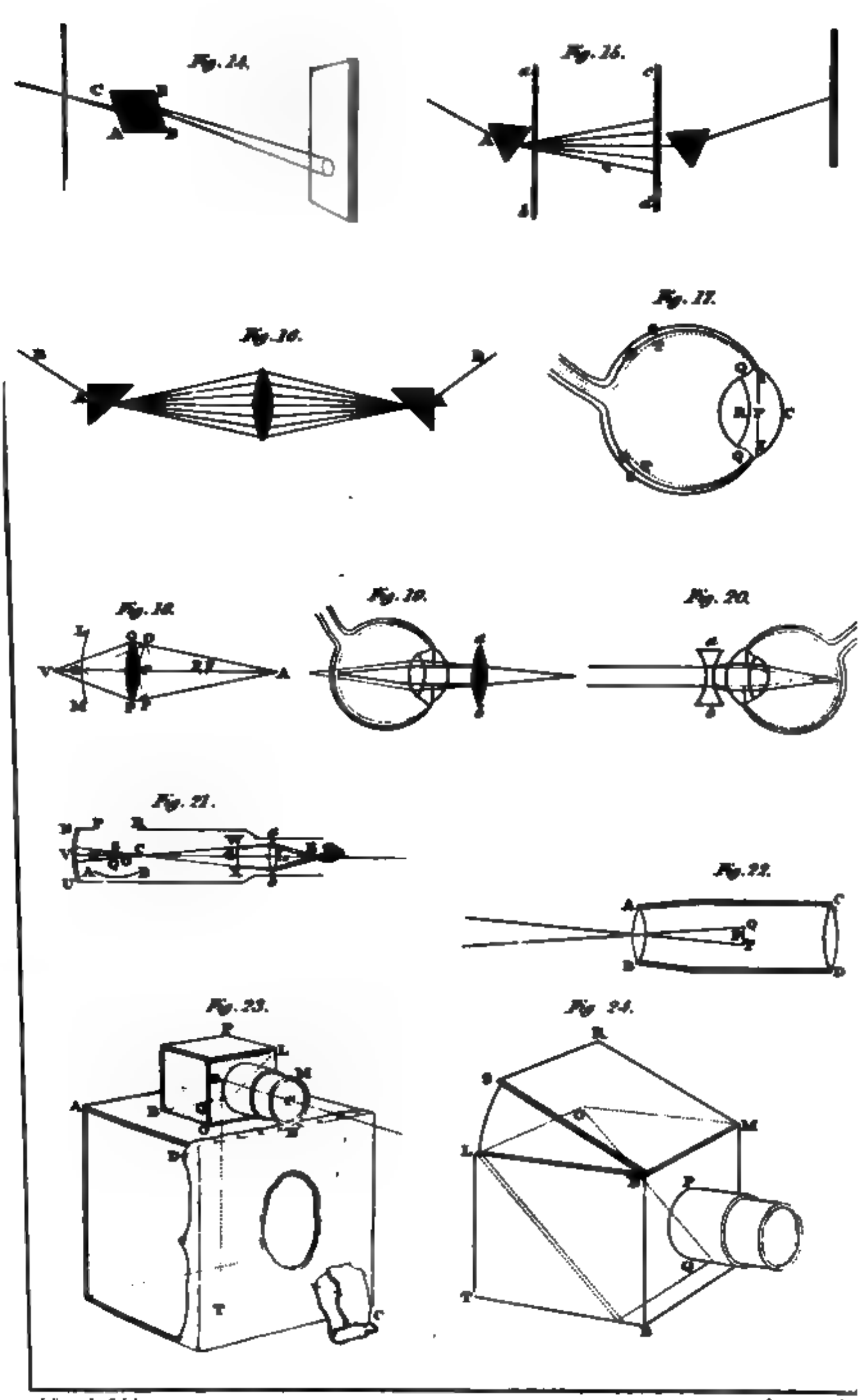

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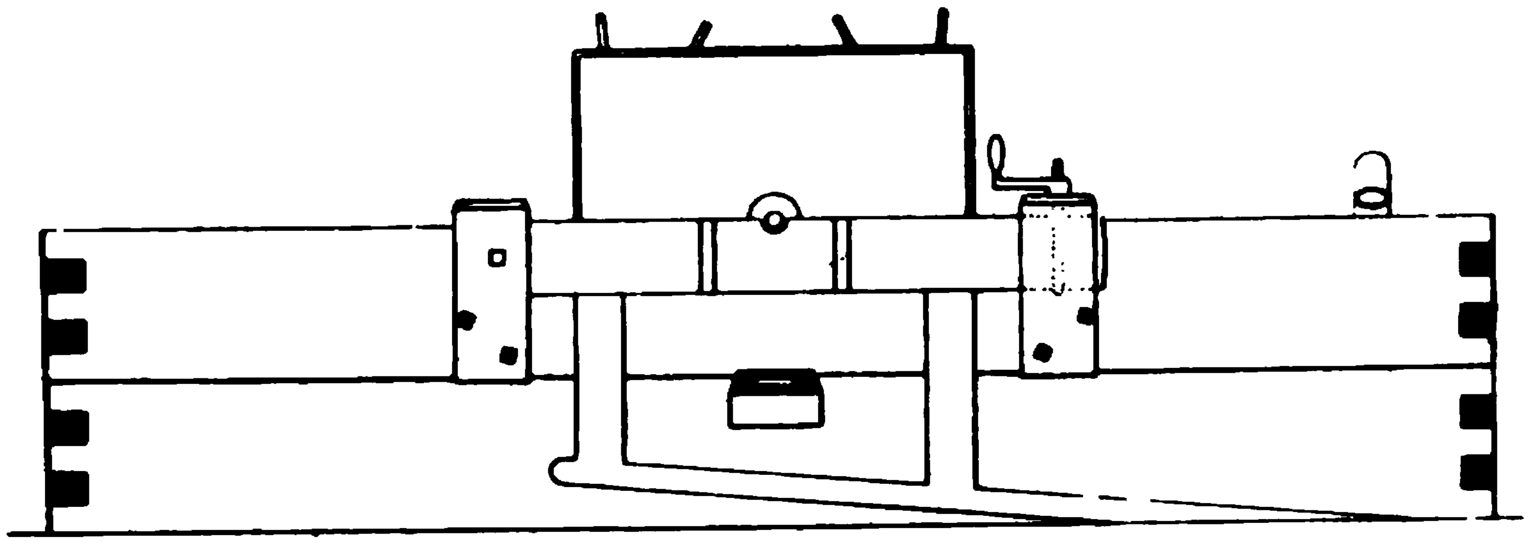
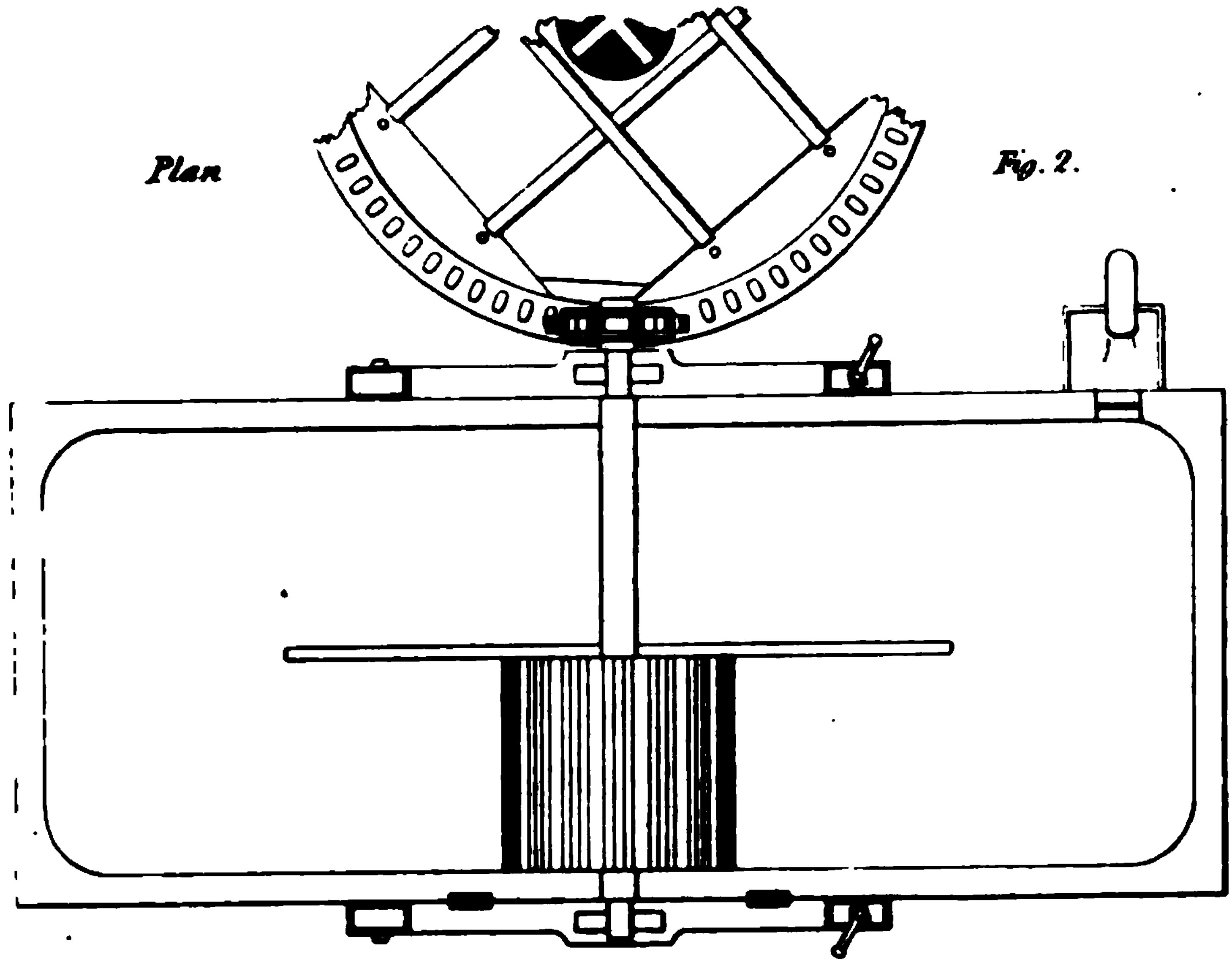
PAPER MILL.

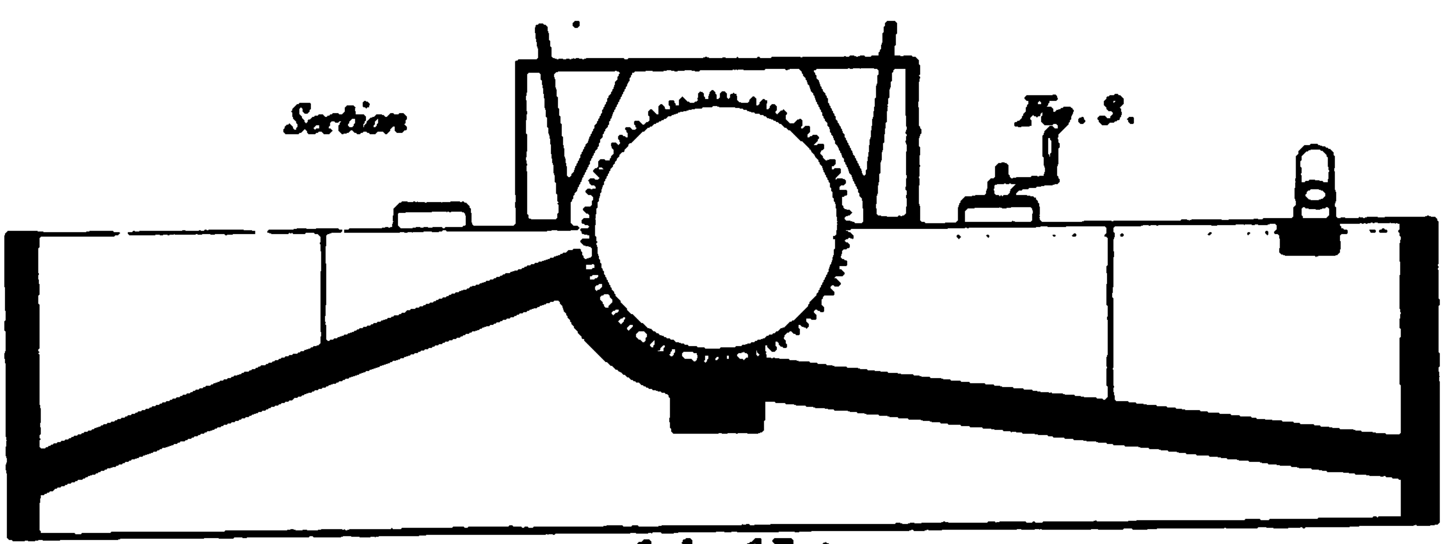
Elevation Fig. 1.



Plan Fig. 2.



Section Fig. 3.



Scale of Feet.

0 1 2 3 4 5 6 7 8 9 10

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BARREL ORGAN MADE BY LINCOLN.

Plate I

Fig. 1.

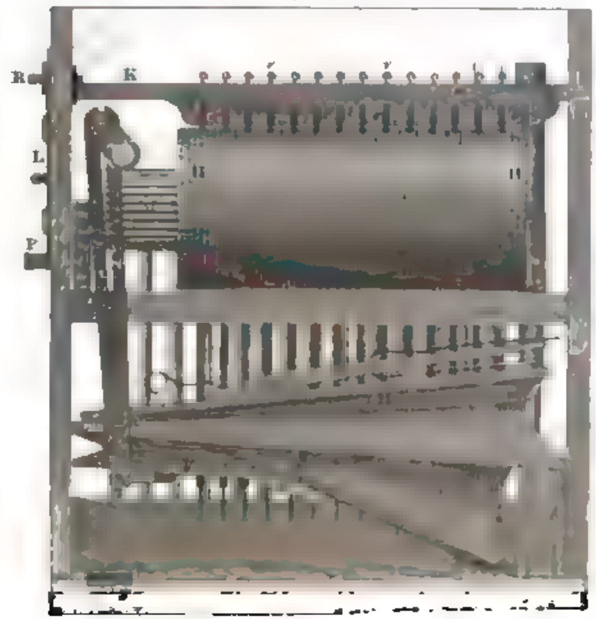
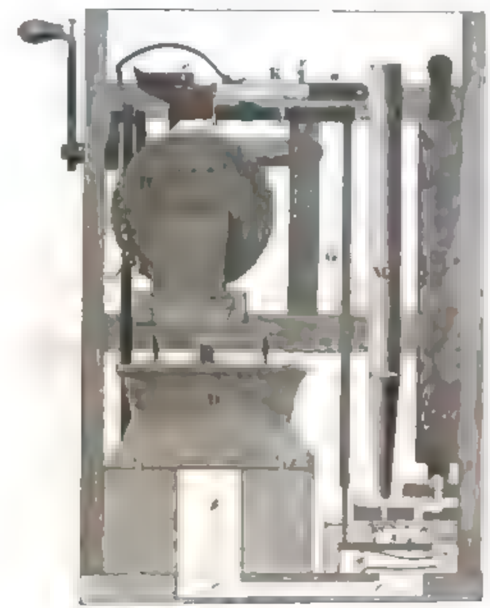


Fig. 2.



PARTS OF BARREL ORGAN.

Plate II.

Fig. 3.

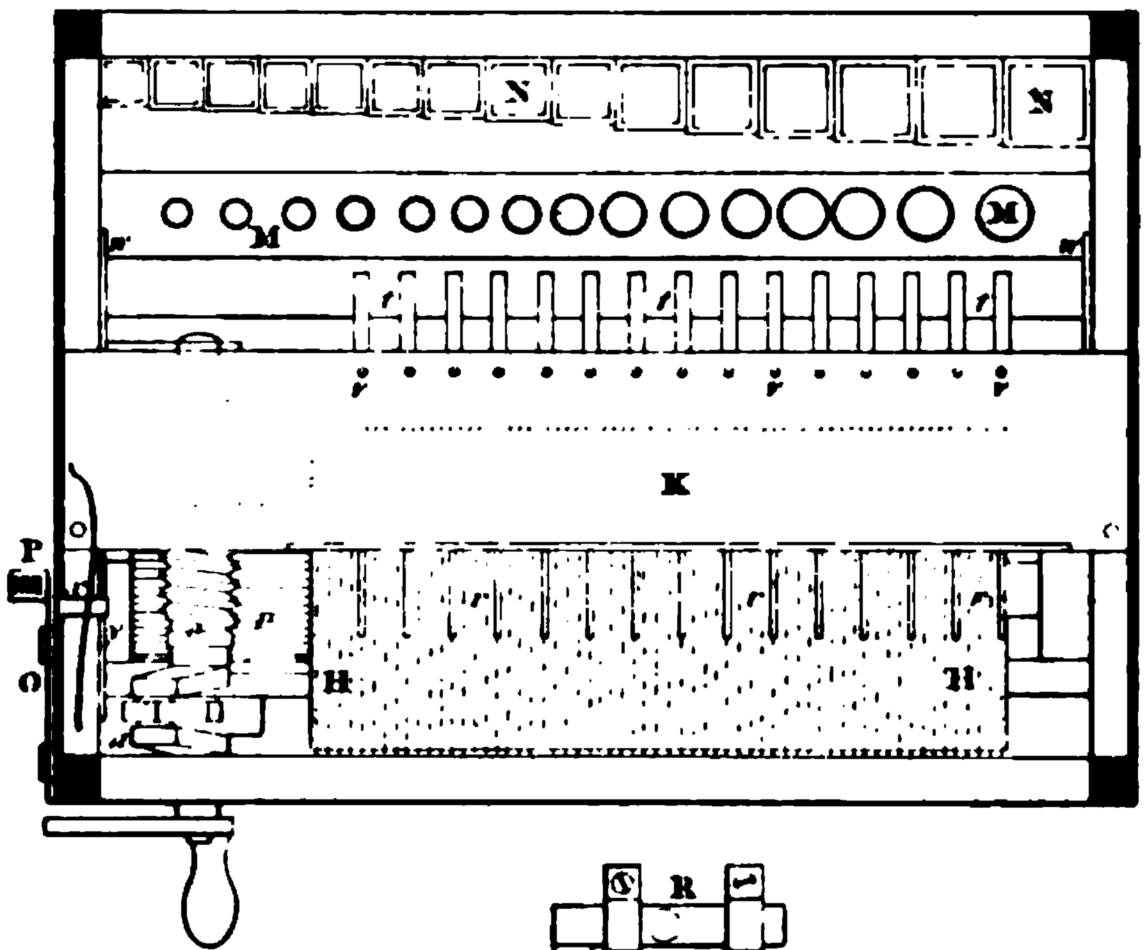


Fig. 4.

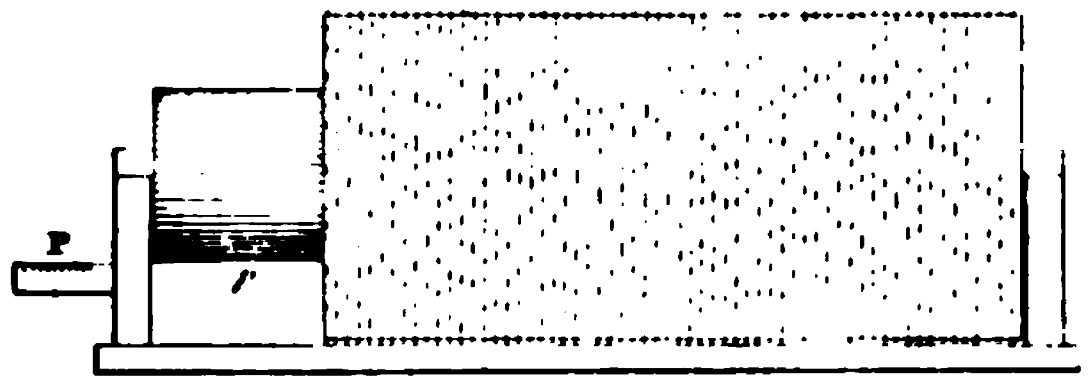
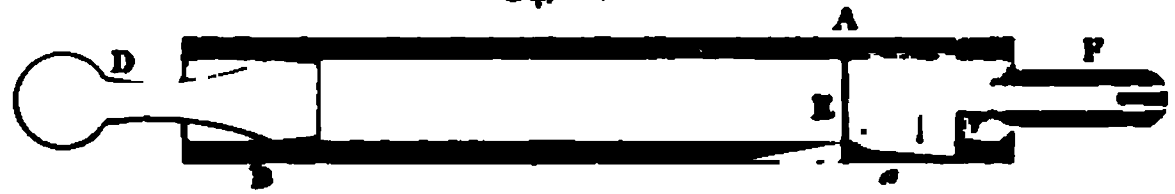


Fig. 5.



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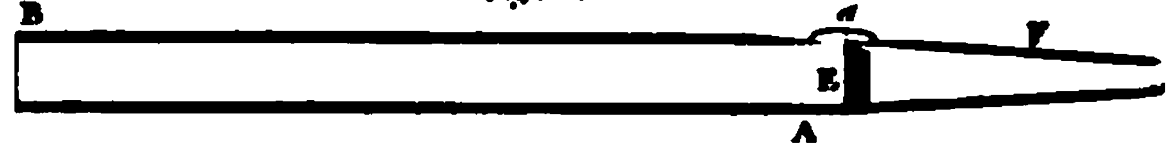

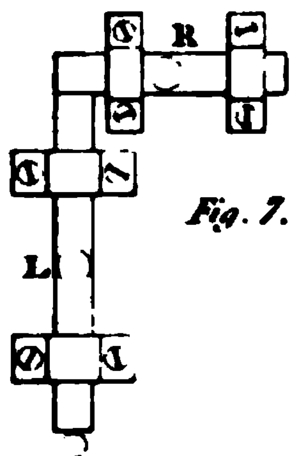

Fig. 7.

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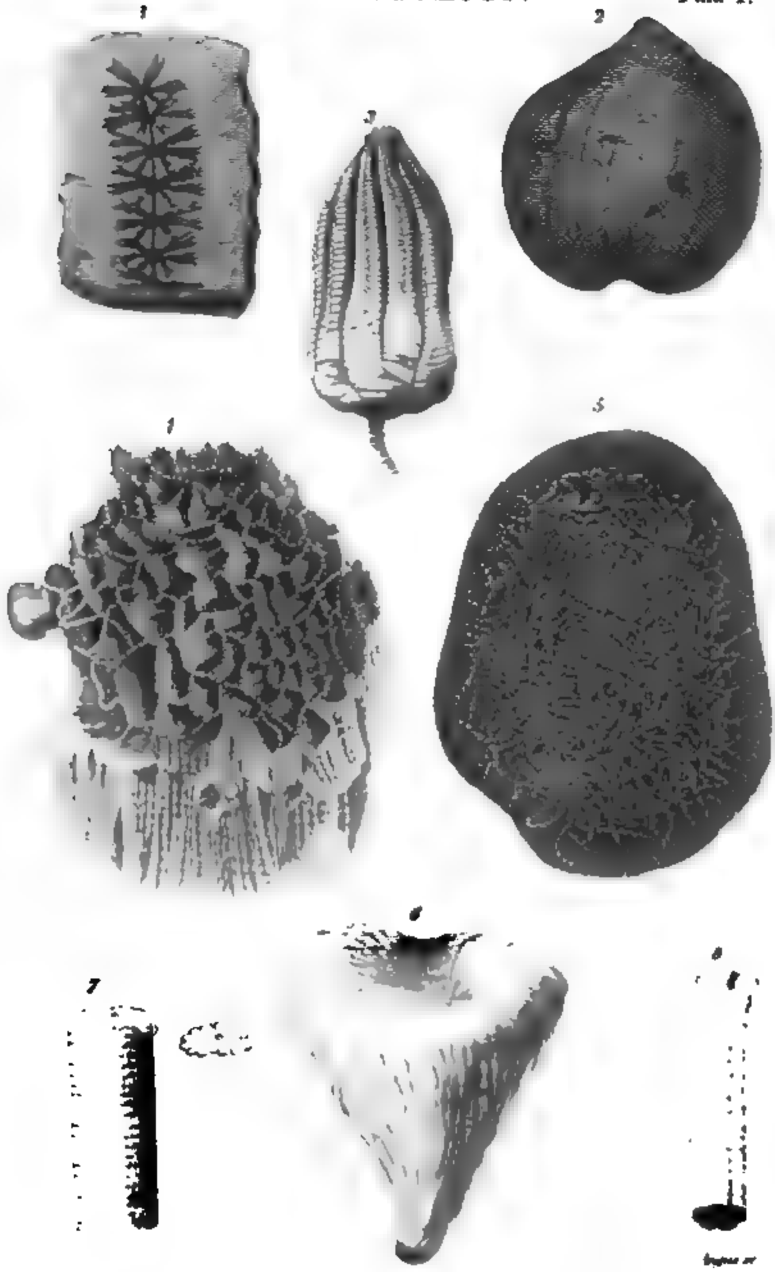
ORYCTOLOGY. *Plate I.*



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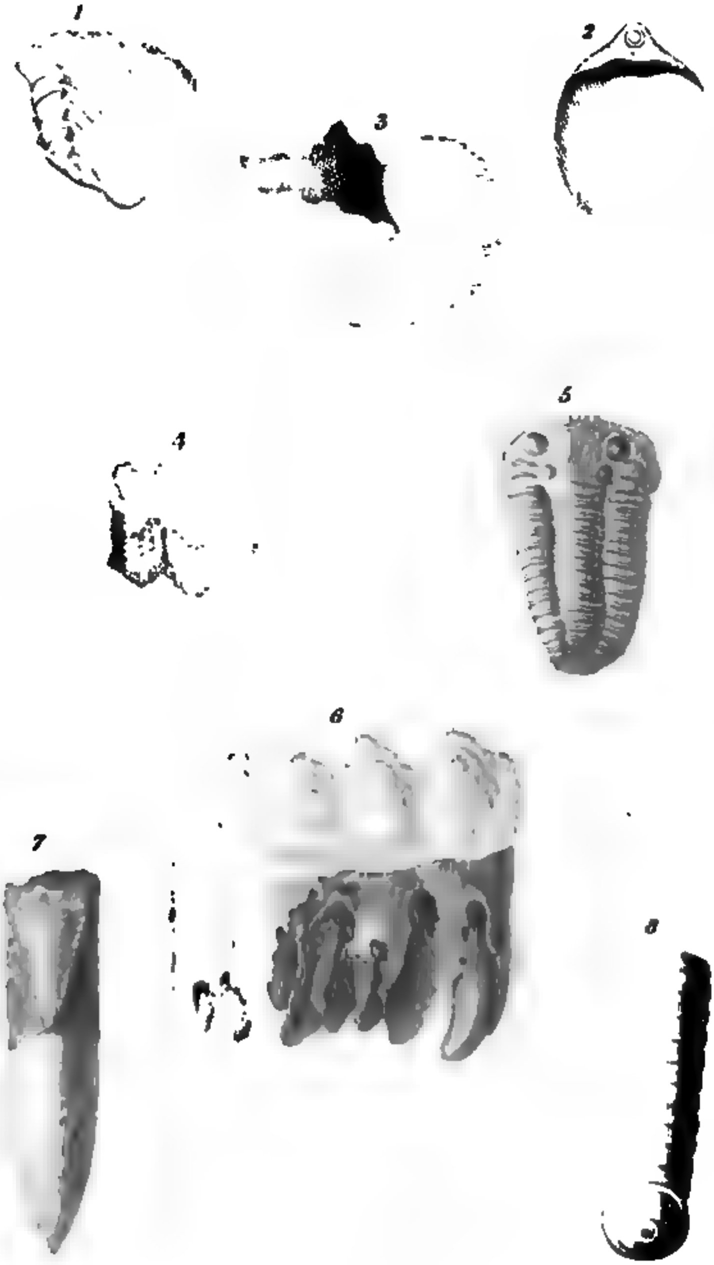
ORYCTOLOGY. *Plate II*



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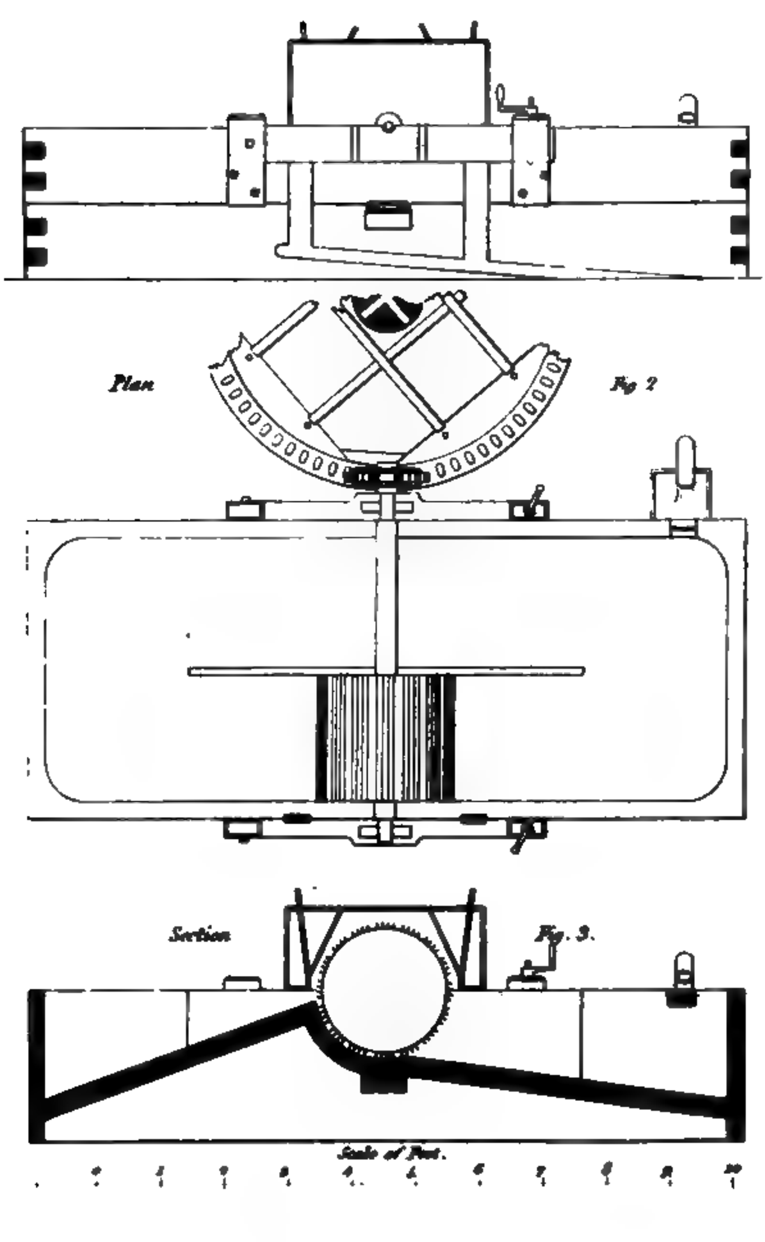
PAPER MILL.



PARABOLA.

Fig. 1.

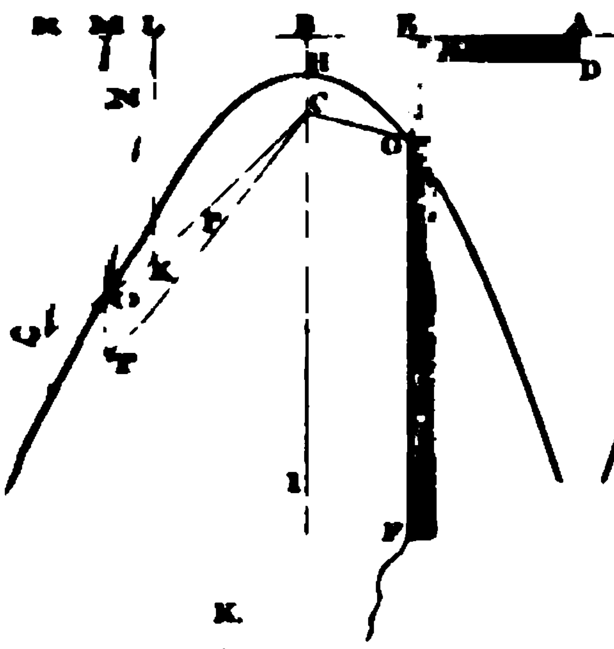
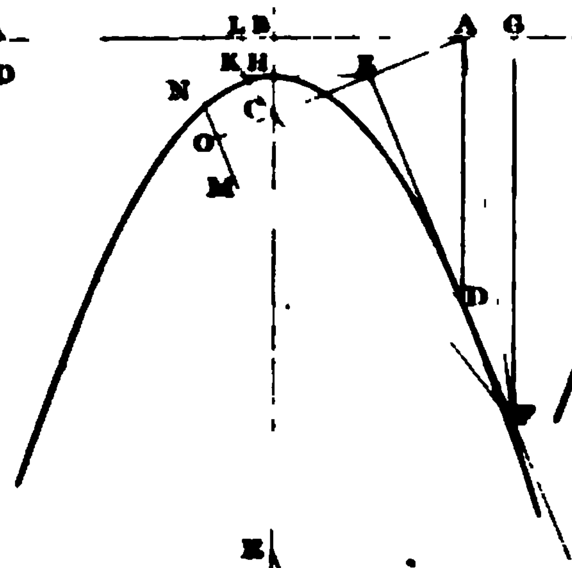


Fig. 2.



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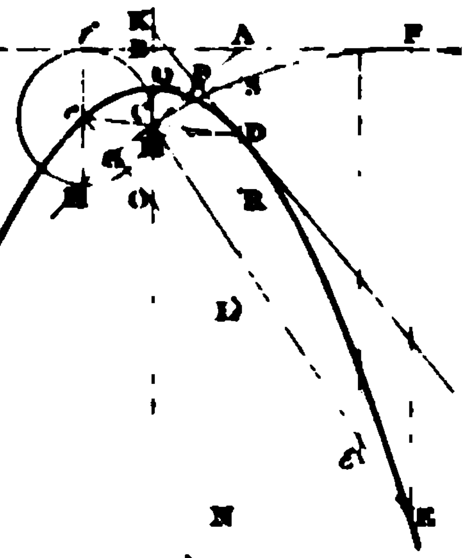

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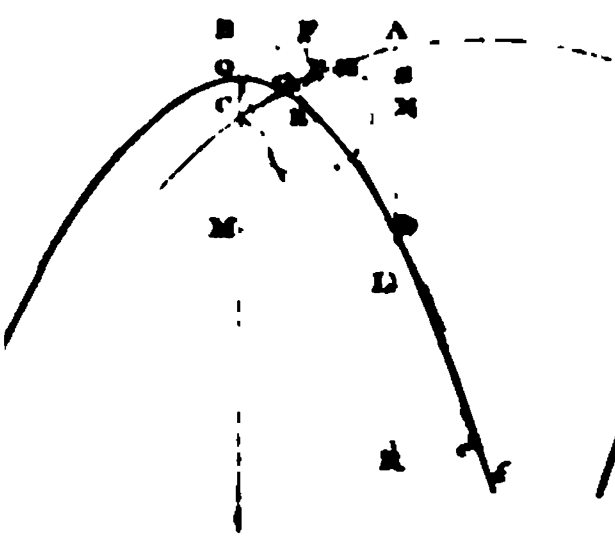
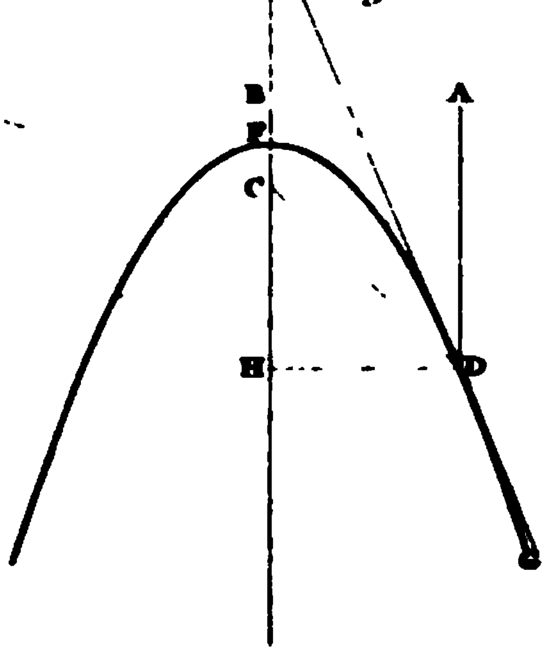


Fig. 5.



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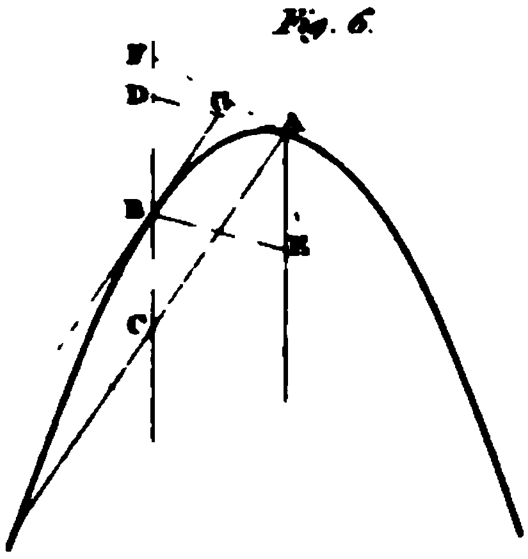

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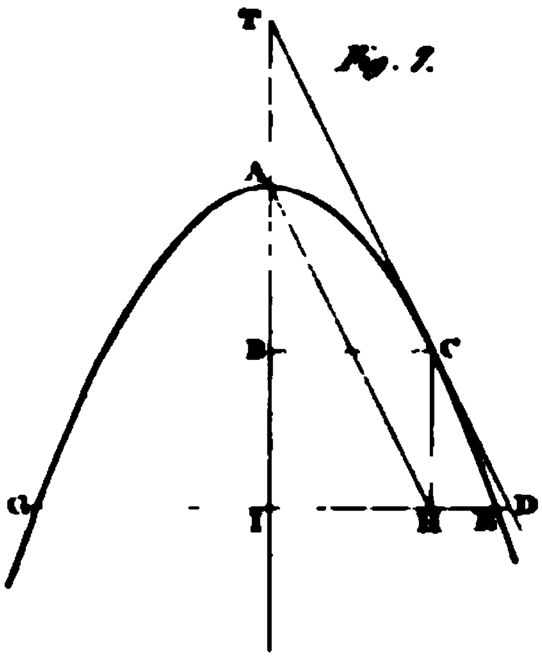

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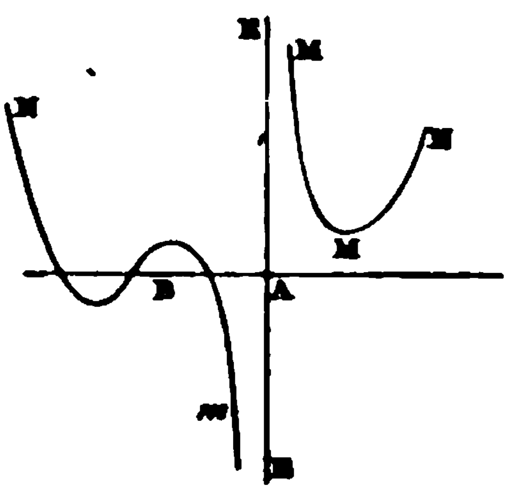

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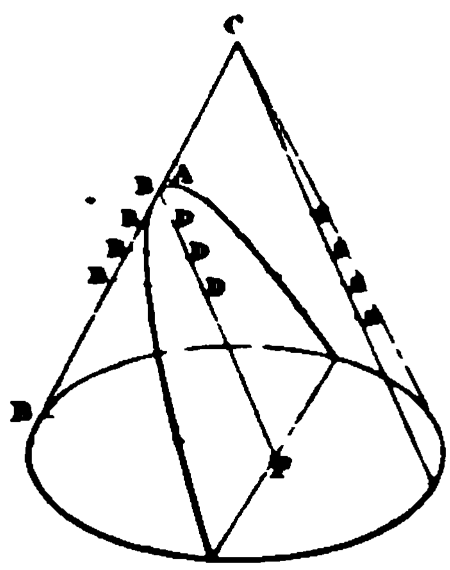

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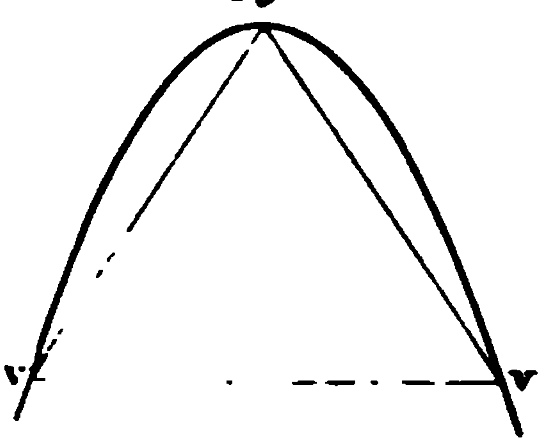

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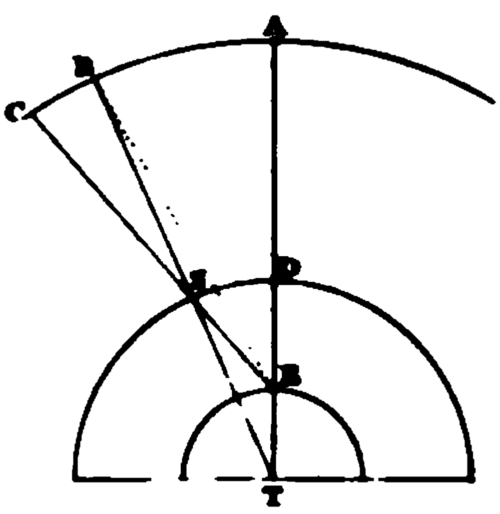

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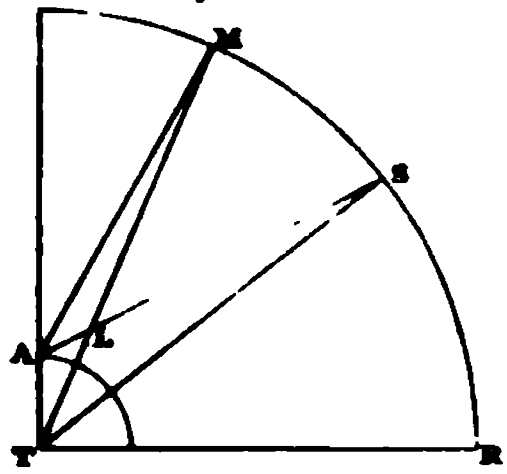

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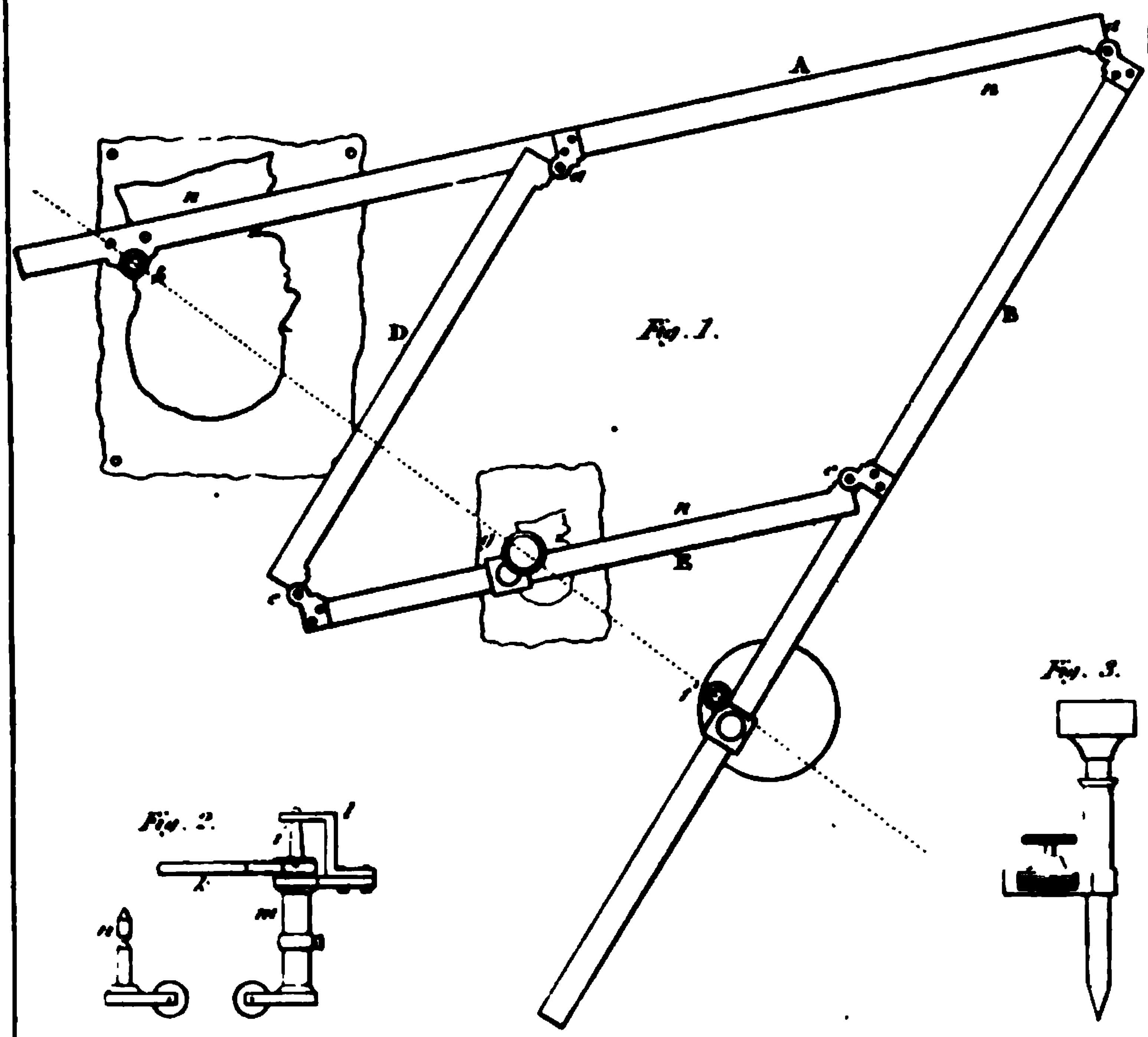
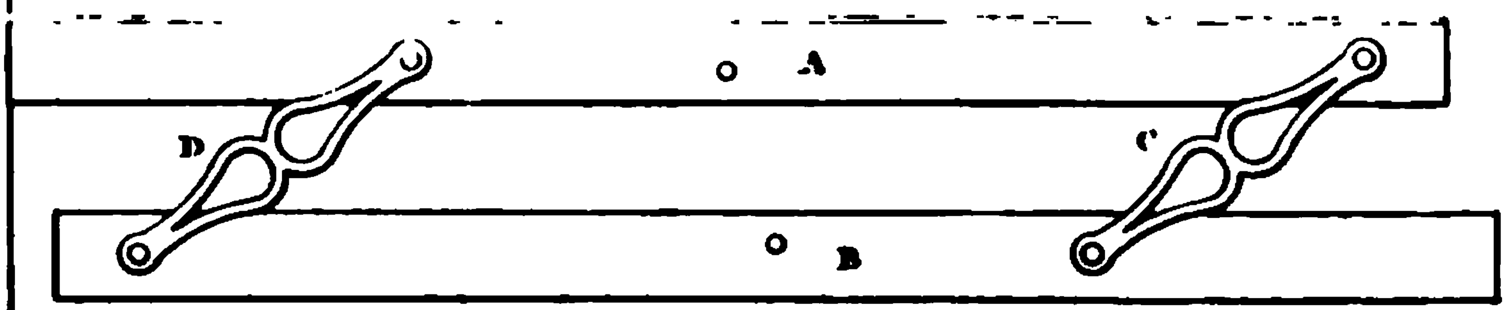
PENTAGRAPH.



Parallel rulers.

Fig. 4.



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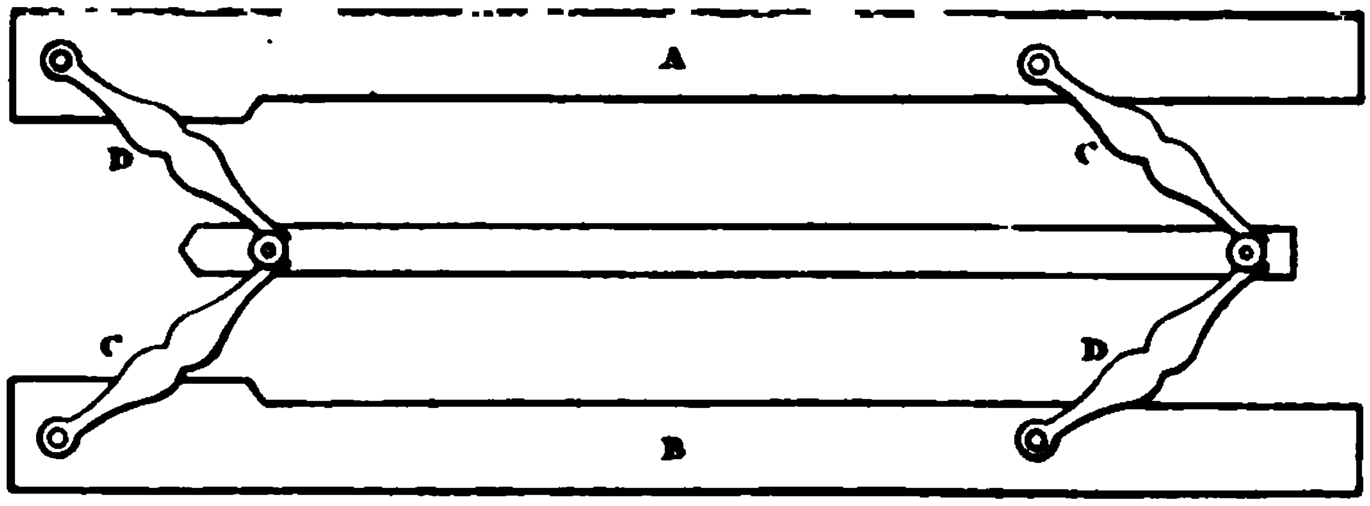

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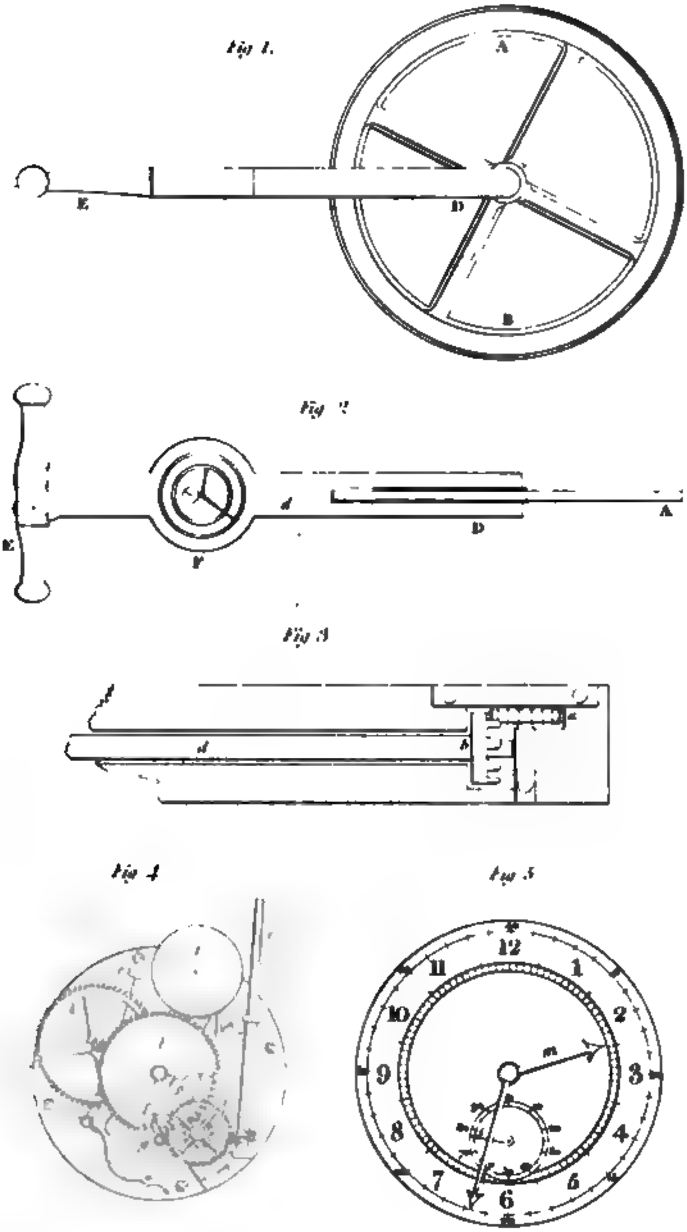
PERAMBULATOR.



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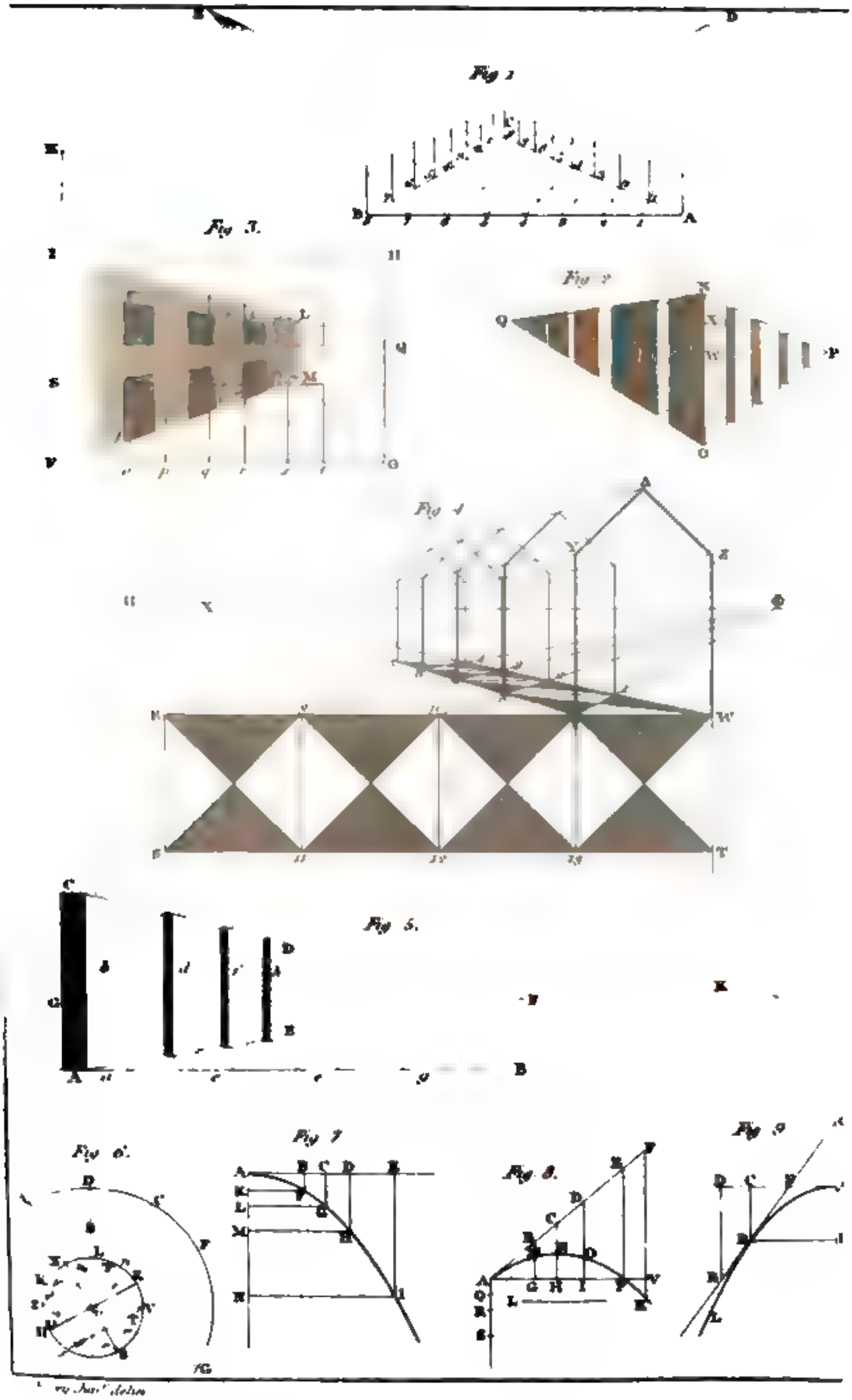
London, Published by Longman Hurst Rees & Orme August 1st [illegible]



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PLANETARIUM.

Elevation Fig. 1.

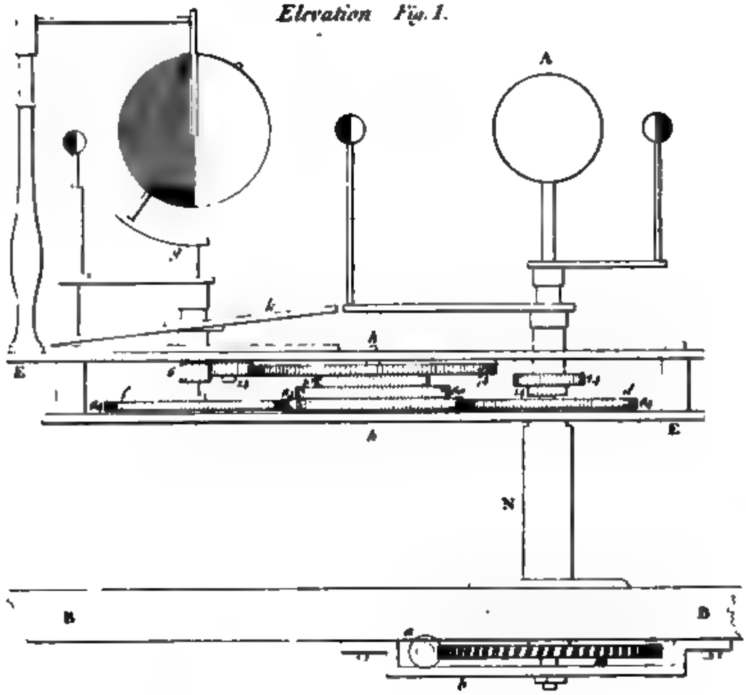
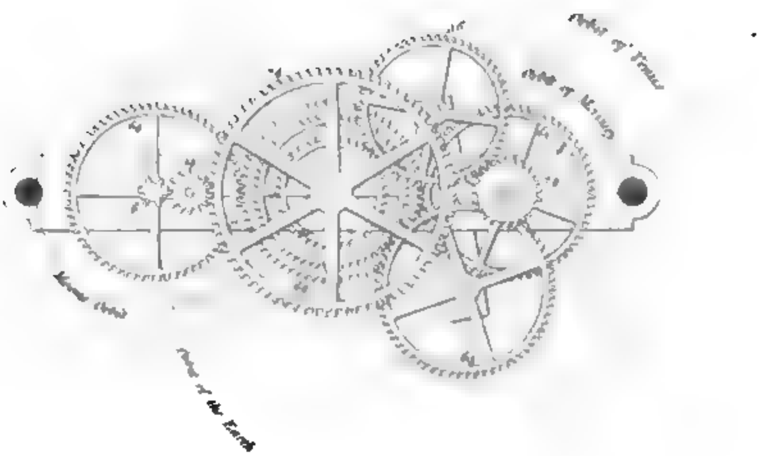


Fig. 2 Plan



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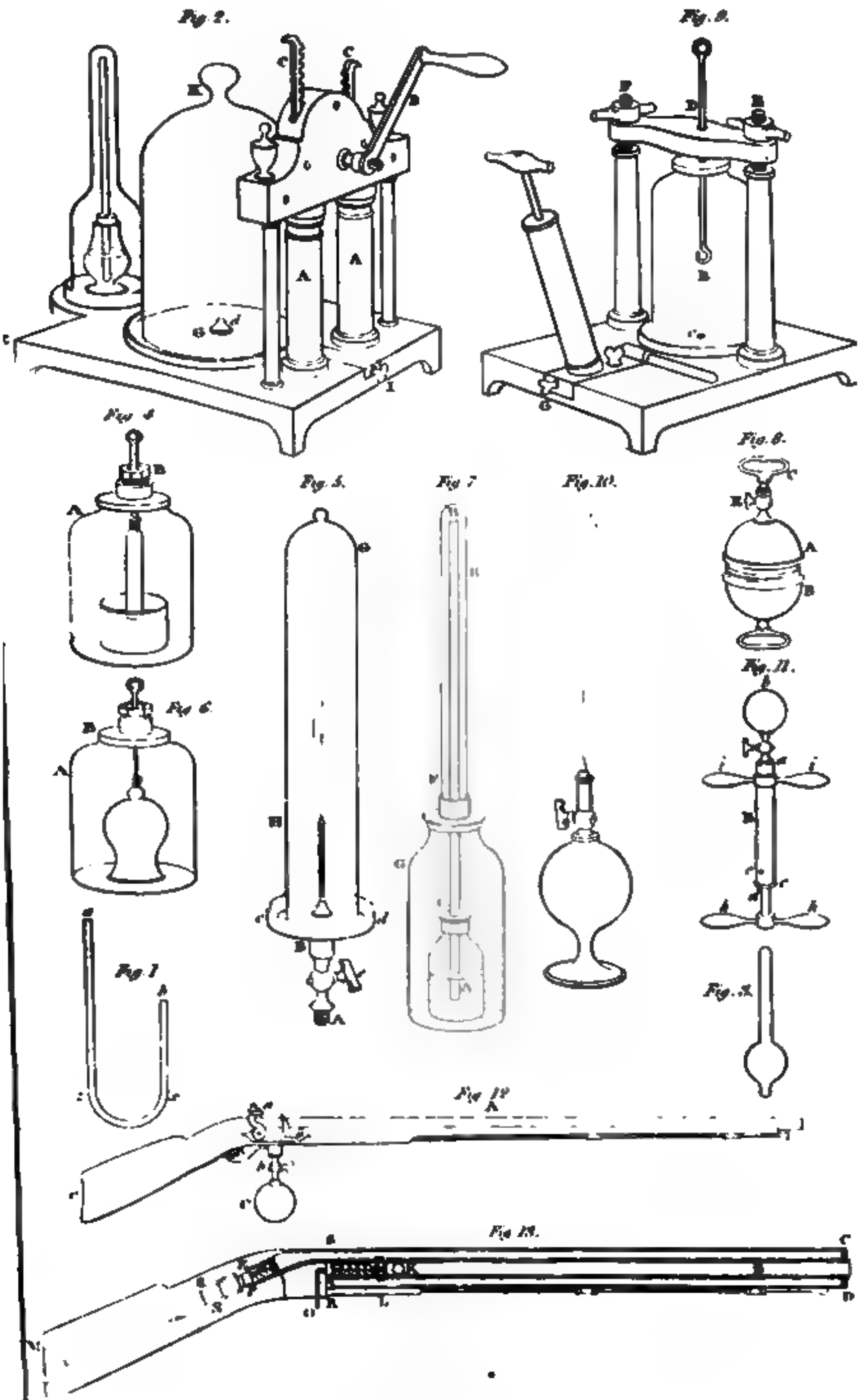


Fig. 2.
Fig. 9.
Fig. 4
Fig. 5.
Fig. 7
Fig. 10.
Fig. 8.
Fig. 6
Fig. 11.
Fig. 1
Fig. 3.
Fig. 12
Fig. 13.

PRESSES.

Fig. 1.

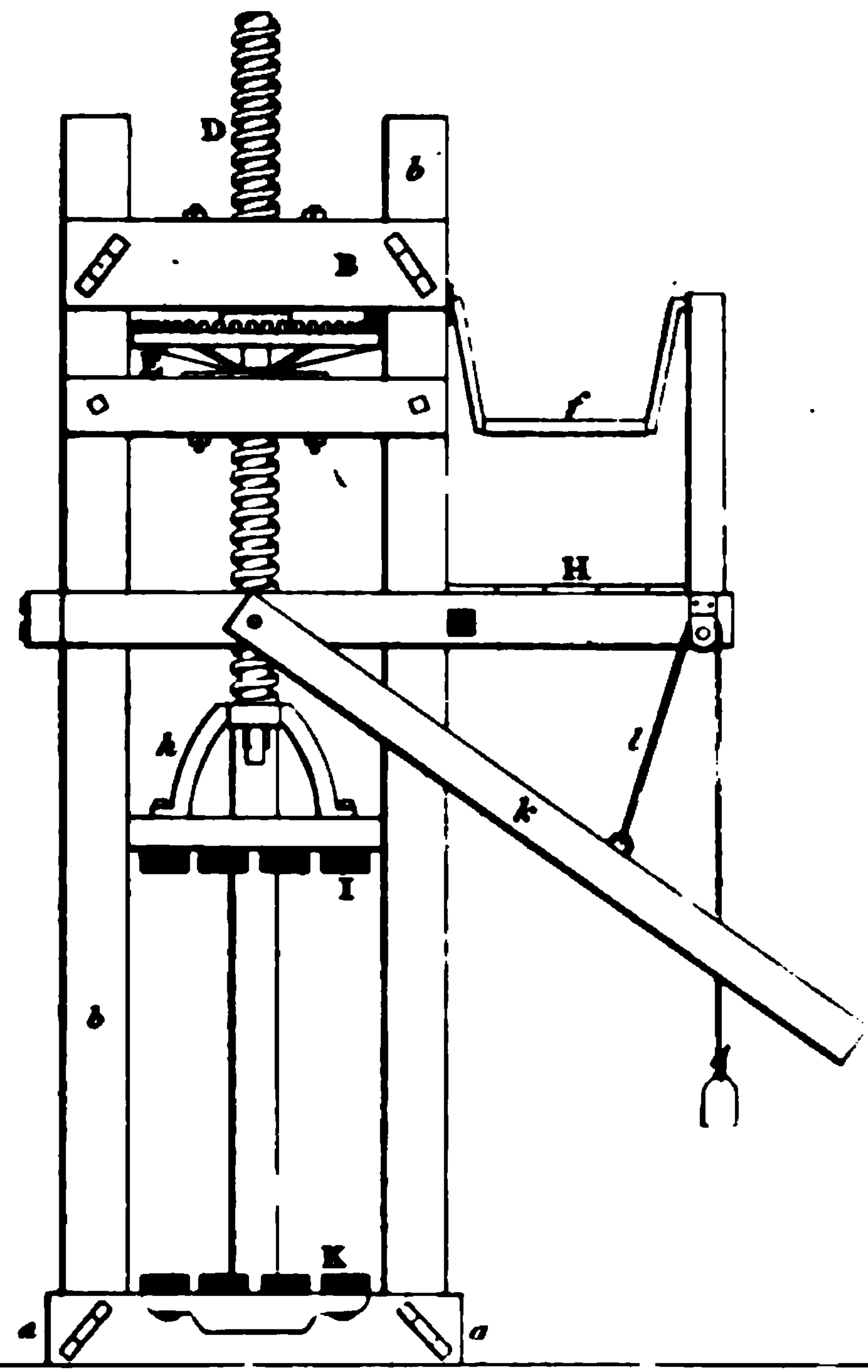


Fig. 2.

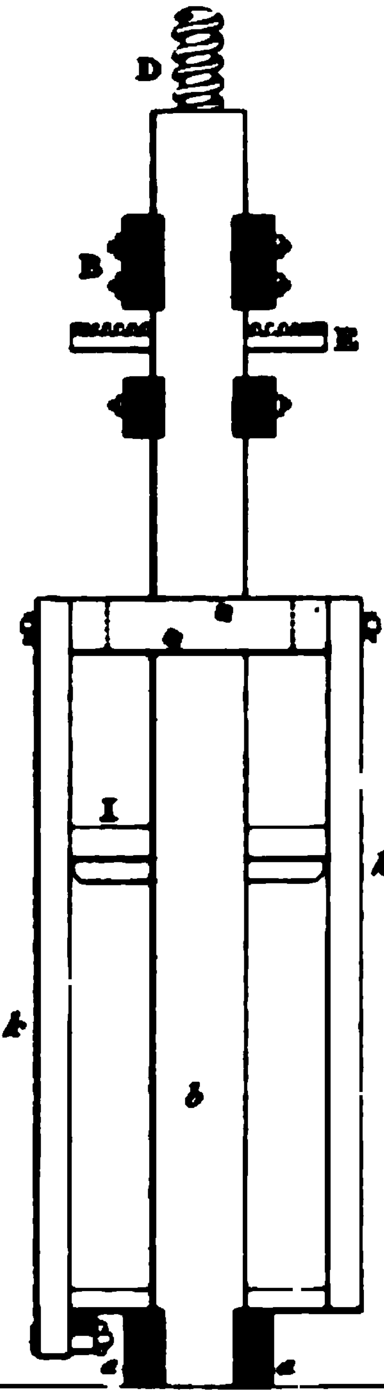
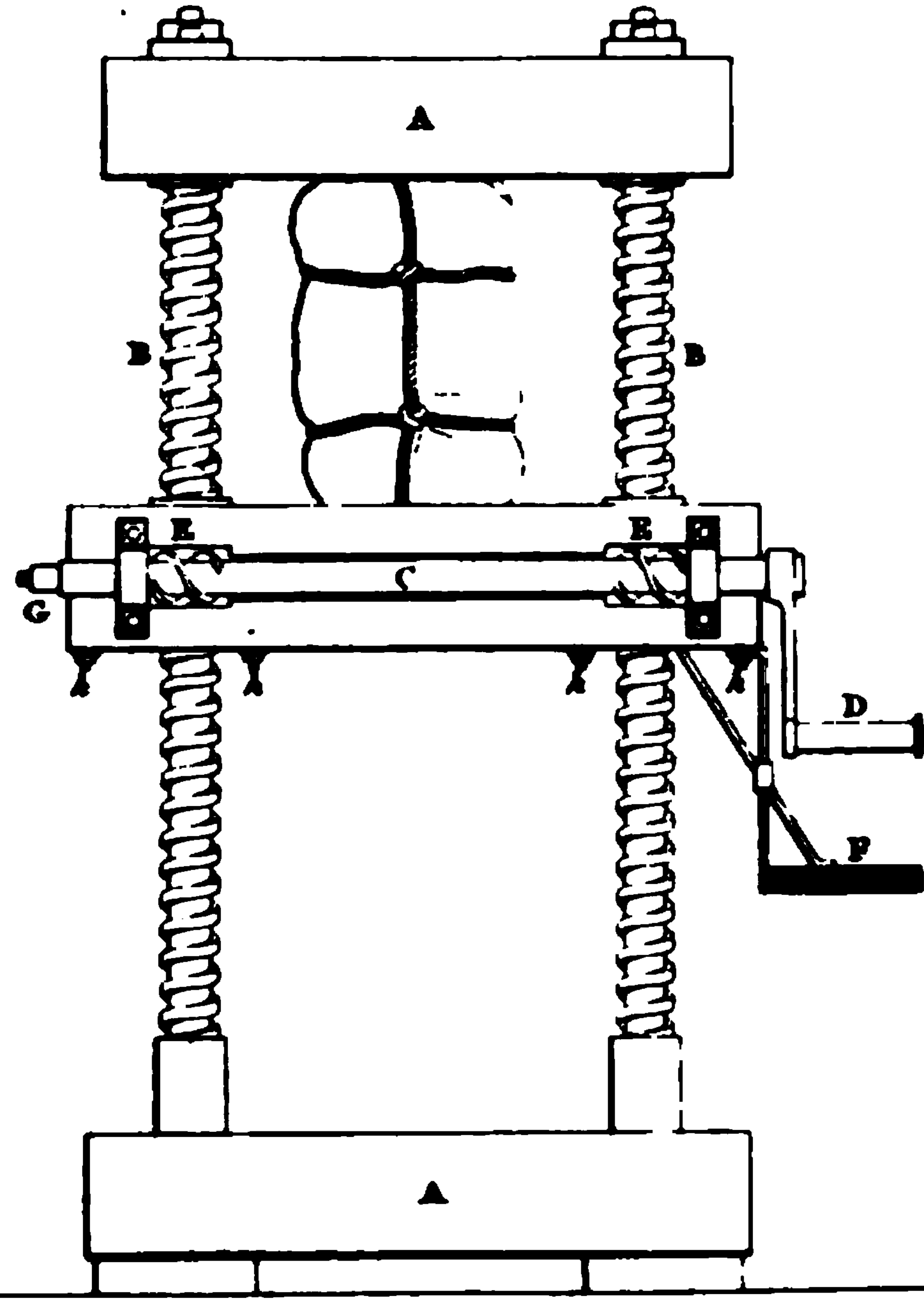


Fig. 3.



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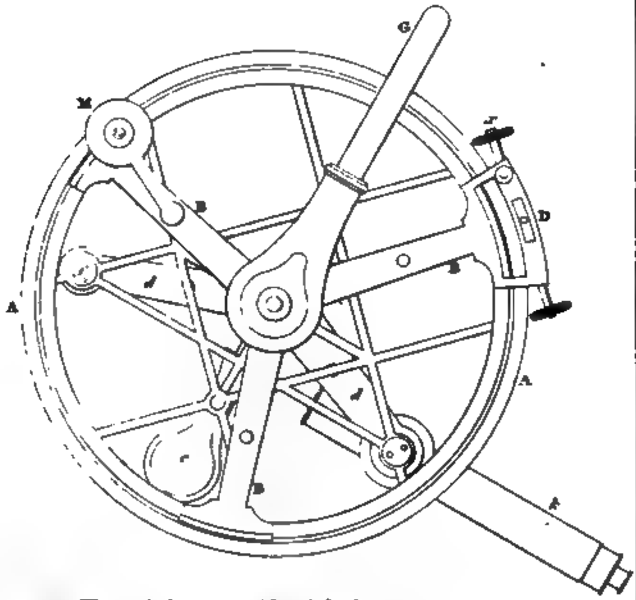
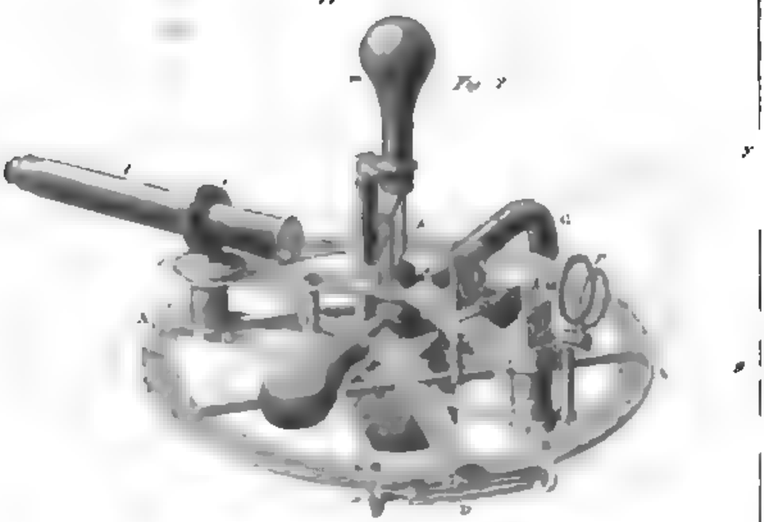
REFLECTING CIRCLE made by Mr TROUGHTON.

Plan Fig. 1.



View of the upper side of the instrument.



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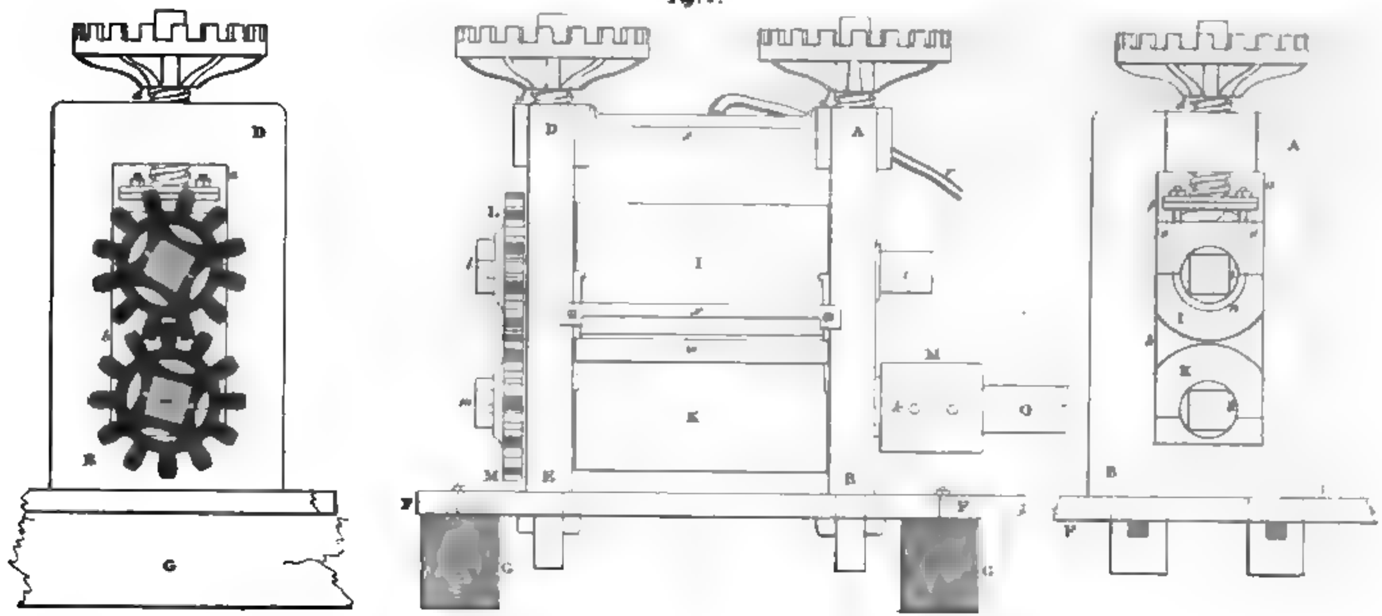
ROLLING MILL.

Fig. 1. Fig. 2. Fig. 3.



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